MADRAS FISHERIES BUREAU.

THE PRACTICE OF

OYSTER CULTURE

AT ARCACHON

AND ITS LESSONS FOR INDIA.

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FIG. 1. SKETCH PLAN of ARCACHON BASIN,
showing the extent of flats and foreshore uncovered at low water, spring tides; the dotted parts indicate these areas.

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THE PRACTICE OF OYSTER CULTURE AT ARCACHON AND ITS LESSONS FOR INDIA.

I.—INTRODUCTION.

In view of the excellent quality of the edible oysters found in many of the estuaries and backwaters of the Madras Presidency, it was considered desirable by the Honorary Director of Fisheries that details of the most practical working methods employed in oyster-culture at the present day should be obtained at first hand before any experimental work on an extensive scale should be tried locally. Advantage of my being home on leave in the summer of last year (1909) was therefore taken and I was requested to proceed to Arcachon for this purpose.

The choice fell upon Arcachon for three reasons: the first because the bay or basin of Arcachon is the most successful and beyond comparison the most extensive oyster-culture district in France, the mother-land of modern oyster-culture; the second on account of the singular aptitude of the Arcachonnais for culture in small lots worked by the members of the lessee's family and without the assistance of outside capital; lastly, because the natural conditions there agree broadly in physical character with those prevailing in Madras waters. The second consideration was perhaps the most weighty in favour of Arcachon, for methods that are successfully carried on by fisher people working independently on what may be termed a small holding system are most attractive to those whose aim is the creation of an industry where no large outlay of capital is necessary, one

indeed which can be carried on by the small proprietor and even by the fisherman and peasant with a minimum dependence upon the capitalist. The practical interdiction by the State of any monopoly in this industry at Arcachon is one of the outstanding features of oyster-culture there and this phase will be duly dealt with at length.

My stay at Arcachon extended from 21st June to 7th July 1909; during this period through the kindness of Dr. André Hameau, President of la Société Scientifique d'Arcachon, and of Monsieur Louis Michelet, the son of a pioneer in oyster-culture ranking perhaps next after Coste, I was enabled to see everything possible and of consequence pertaining to the industry. Dr. Hameau placed the motor boat belonging to his Society at my disposal in order to visit whatever oyster parks I might wish and gave me facilities to examine at leisure the valuable series of culture exhibits in the museum and aquarium forming part of the fine Biological Station of which Arcachon is deservedly proud. To the Rev. Mr. Radcliff I am also greatly indebted for much patient assistance while in regard to Monsieur Michelet I can only say that I can neither sufficiently acknowledge his extreme kindness in accompanying me day after day in my wanderings nor express my admiration for the patience he showed in answering my apparently interminable string of questions. I remember, however, that I had extreme difficulty in finding any further queries on the last day of my stay. But everyone I came into contact with afforded me assistance to the utmost; this universal courtesy and helpfulness to a stranger is most pleasant to record, and the more remarkable as I went with no introductions whatever.

The date chosen for the visit could not have been better timed; the weather during the spring had been chill and inclement and in consequence cultural operations were several weeks later than usual. Usually all liming of tiles is completed by the beginning of June and the bulk of the collectors are laid down by the end

of that month. Last year liming operations were in full swing up to the second week in July and I had a somewhat unlooked for opportunity of seeing every process connected with the preparing of collectors, the liming and stacking of the tiles, their transport in barges, often towed by motor boats, to the parks and the placing and filling of the collector frames along the margins of the channels. The methods of protecting the young and the injured till the shell thickens sufficiently to permit them to be scattered over the surface of the "claires," the various ingenious plans devised to protect the older oysters from their many enemies, the raking and spreading and general routine work of an oyster farm, and even the methods employed to prepare and fit new sections of the sea bottom for oyster-culture were all studied in operation ; of the details of the more important I obtained permanent records in the form of photographs, some of which are used in the illustration of the descriptive portion of the present report.

Arcachon I confess proved a revelation to me. Few, I think, appreciate what strides this small Girondin fishing district has made in the past few years ; few will realize that it is now the second fishing port in France as well as far ahead of all others in oyster-farming. It owned in 1909, 43 steam fishing vessels mostly trawlers (among them are some larger than any British-owned) and has over 200 motor fishing boats engaged in the sardine fishery. It may also be said to have become the present-day çentre of the French sardine canning industry which is rapidly transferring its factories to this district ; some dozen factories have been erected during the last two years alone. Of small boats registered at Arcachon, of which the majority are employed in fishing and in oyster-culture, the numbers run well above 9,000. Except in respect of the trawling concerns and sardine factories the local marine industries are conducted on the family basis or upon the share system ; a feeling of quiet prosperity is the dominant note in the villages and hamlets. Comfortable cottages usually with a patch of

vines attached and fenced in with the parts of worn-out oyster-cases (ambulances) are seen everywhere. On enquiry one finds that the head of the family, almost invariably a naval reservist (*marin inscrit*), leases a small oyster-park which the family labour usually suffices to cultivate. The land around the cottage supplies most of the daily requirements and often enough the industry of the wife and children sets free the husband to earn good wages by periodical voyages aboard deep-sea fishing craft.

From such a land of sober, industrious, and thoughtful people much may be learned and of what it has to teach in regard to the culture of oysters the following pages contain, I trust, all facts of essential importance.

II.—PHYSICAL CONDITIONS CHARACTERISING ARCACHON BASIN.

The basin of Arcachon is a land-locked shallow bay of great area lying about midway between the mouths of the Garonne and Adour in the old province of Gascony; it lies about 35 miles westward from Bordeaux.

Its area at high tide is estimated at 15,000 hectares or 37,066 acres; at low tide the appearance wholly alters; extensive and numerous sand banks and mud flats emerge in all directions and the water area becomes reduced to a network of mud-bottomed channels. At ordinary springs when there is a vertical range of about 10 feet fully 8,000 hectares are uncovered at low water, being more than half the superficies of the bay at high tide. The shore line measures 85 to 90 kilometres (about 55 miles). Its outline is roughly that of an equilateral triangle (Fig. 1), the narrow seaward entrance being situated at the western extremity of the base, while the delta of the only large river, the Leyre, is situated at the other end of the southern side of this triangular bay; at the northern angle (apex) a small stream, the Lege, enters the bay and in times of exceptional floods may exercise

considerable influence upon the channels in the north-western section.

The sea outlet is extremely narrow, scarcely 3 kilometres wide, and this again is so obstructed by sand banks that the effective navigation channel has no greater width than 170 yards. As a consequence of the narrowness of the outlet and the obstruction caused by the presence of extensive sand banks in the fairway, the tidal outflow is retarded ; a considerable body of water never drains out on any ebb and the tide cannot rob the basin of its total spatfall as is liable to happen at less favoured oyster centres where the ebb runs out through wide and more or less unobstructed passages.

The banks of the basin are of shifting sand in the western section, rising sharply into high dunes thickly clothed with pine trees. In the eastern section the banks are low and marshy, composed of marl and mud brought down chiefly by the Leyre whereof the delta has advanced according to historical evidence about 1 kilometre within the last ten centuries. Advantage has been taken of the network of small channels formed in this deltaic region to construct numerous fish farms, *reservoirs à poisson*, of considerable economic value and several of very extensive area.

The flats or *crassats* which emerge at low tide are composed of a basis of muddy sand, stiff and well consolidated, overlaid generally by a thin layer of mud. Towards the margin as the flats shelve abruptly into the bounding channels the mud deepens to such an extent that the workers have to use special shoes or sandals having large wooden plates attached to enable them to walk over it ; the higher levels of the flats form the bulk of the oyster culture area, the firm surface facilitating operations. Of recent years complaints have become numerous of a marked increase in the amount of sediment deposited upon many of these grounds particularly in the eastern and northern sections of the basin and it would appear as if the tidal scour were being interfered with by some agency to such an extent as to retain in the basin

much sediment which, under former conditions, would be swept out to sea. The deep channels separating the flats appear to form the natural home of the local oyster; for many years Government looked upon such beds as breeding reserves and limited fishing to one day in the year and then only for some two hours.

The specific gravity of the water has no special peculiarity. As may be expected it approximates to that of the open sea in its seaward section under ordinary conditions; during and after rains the salinity and specific gravity fall, as is but natural, especially in the northern and eastern regions. Bashford Dean gives the specific gravity as 1·0189 at the end of August (that of the open sea being about 1·0267), but does not state the locality of his observation. Schmarda, on the other hand, is quoted as giving the salinity as higher than that of the Mediteranean. Such discrepancy is easily understood by anyone who has studied any large land-locked body of water having imperfect communication with the sea; a reading of the hydrometer taken in bays remote from the mouth after prolonged continuance of dry weather will furnish a high figure, whereas one in a locality which is effected by the entrance of river or flood water will naturally give a very low one during and immediately after a spell of rainy weather. We are safe in stating that the salinity varies considerably in different sections of the basin and at different states of the tide and according to the season of the year; a statement proved by the fact that two of the diseases to which the oyster is subject are recognised at Arcachon as due in the one case to an excessive amount of fresh water and in the other to excessive salinity. The former, *douçain*, is well known and dreaded as the cause of great mortality; the latter, due to abnormal scarcity of rain, is declared to be exceptional or rather that it scarcely ever is so severe as to cause much loss.

Taken generally it appears that upon the average the specific gravity of the water of the basin is usually slightly below that of the open sea.

The extremely narrow outlet to sea, the oblique course of the passage, and the high dunes, covered with a dense forest of closely-set pines, give almost perfect immunity from the evil effects of sea-storms; in this peaceful security the routine of the culture of oysters can be carried on whenever operations are necessary, whatever the season of the year.

III.—THE ORIGIN AND DEVELOPMENT OF OYSTER CULTURE AT ARCACHON.

An almost simultaneous exhaustion of natural oyster banks took place on all the coasts of France about the middle of last century and the causes which occasioned this phenomenon have lessons specially worthy of attention in India to-day, where present conditions are running parallel with those of France 60 years ago; it is noteworthy that the alarm caused by this general failure of the oyster fishery was the spur which set the machinery of Government to work to find a remedy and thus, by giving to Coste and a number of less well-known men whom his enthusiasm brought into the field, opportunities for prolonged experiment on a very extensive scale such as only the resources and authority of a State could supply, eventuated in the creation of a new and most valuable industry for France. Until the beginning of the 19th century the means of communication throughout the greater part of France were so inefficient that the distribution of oysters from coast centres was extremely difficult. In spite of this disability the increase of luxury which characterised the 18th century entailed such a drain on the resources of the natural oyster beds that in the case of Arcachon the Parlement de Bordeaux felt compelled in 1750 to order and maintain the suspension of all oyster fishing there for three years, with very satisfactory results; in 1754 and 1759 the Amirauté de Guienne passed orders forbidding for the future all fishing during the spawning season from 1st April to 1st October

and prohibited the use of rakes in gathering the oyster as well as the piling of them in heaps on the flats as this entailed the death of all small oysters rejected by the buyers. At this time the Arcachonnais, owing to the difficulties of transport, were in the habit of opening the oysters before despatch, sending away the flesh in various receptacles which they transported to Bordeaux on pack horses. Bullock carts and then lighter horse-drawn vehicles followed at a somewhat later date enabling the oysters to be transported in their shells in better condition and to greater distances. The demand increased steadily, more fishermen devoted themselves to the trade, the old restrictive rules of the Bordeaux Parliament fell into disuse during the stormy days of the Revolution and in 1800 we read that the annual despatch of oysters to Bordeaux amounted to 5,000 cart loads, each containing 60 baskets of an individual capacity of 250 oysters. The total annual export was at this time as much as 75,000,000 oysters of a value of about 225,000 francs, *i.e.*, at the average rate of 30 centimes (3 annas) per 100. From this time onwards unrestricted fishing, spurred on by the large profits obtained, became ever more active. Hundreds of boats dredged in the channels with feverish haste; hundreds of men tramped over the flats raking together every sizeable oyster they could see and in 1836 even steam power was tried on a dredging boat. Year by year saw a gradual degradation of the flats owing to the continuous and unrestricted removal of the hard material, almost entirely dead shells, to which the living oysters were attached. No effort was made to return to the beds any of this cultch; year by year in the spawning season the spat had increasing difficulty to find foothold and the set of spat began to decrease appreciably. In 1831, an excellent trunk road was opened between the basin and Bordeaux rendering transport still more easy and entailing further stimulus to the reckless exploitation of the oyster beds. About this time the value of the oysters exported from Arcachon was still about 70,000 francs, a great falling off from the value in 1800. From

this date it fell more rapidly and the scarcity of oysters became so pronounced that Government intervened tardily and in 1840 reimposed the regulations of 1754 and 1759—measures too feeble and too long-delayed to be effective even had they been properly enforced; in point of fact they were ignored.

In 1848 scarcely any oysters remained in the basin; the greater part of the former oystermen had turned their attention to other callings; and now when at last the people of the district fully appreciated the extent of the calamity their own lack of foresight had entailed, they realized that no mere regulation of the fishery would serve; oyster beds were now practically non-existent in the basin and it was universally acknowledged that the only remedy would lie in the replenishing of the oyster stock from outside sources and the adoption of some simple cultural methods. Local committees were formed and approached the Government for sanction to their proposals. The principal of these requested permission for private individuals to appropriate, under Government lease, suitable sections of the old oyster flats and there to form artificial oyster beds or "parcs" where oysters might be grown and fattened; the petitioners predicted that the spat emitted by these parent oysters would settle on adjacent flats and restore little by little the fertility of the whole cultivable area of the basin.

The Government agreed to the proposals and in 1849 sanctioned the creation of a system of concessions whereby suitable applicants should be permitted to occupy portions of the foreshore and oyster flats for the purpose of creating oyster parks. Although their demands were thus granted in full the optimistic anticipations of the local committee were slow of fulfilment; no fishermen came forward to take up concessions; they did not care to risk their small capital in an adventure where the outlay was immediate and the profits deferred and even problematical. Only a single concession was applied for and that came from an outsider from Bordeaux who in 1849 took up 4 hectares (10 acres) of ground and spread

thereon a quantity of oysters collected from the channels. This venture unfortunately was made during a bad year when floods were exceptionally great ; the oysters died off from *douçain* or fresh-water sickness ; in disgust the holder renounced his concession. This failure still further disinclined the former oyster fishers to risk time and money in parkage experiments and it required the enthusiasm and surprisingly great initial success of Coste in his experiments on the coast of Brittany to overcome this very natural caution and to inaugurate the new era ; indeed it was high time seeing that in 1858 the total produce of the natural oyster beds of the basin had dwindled in value to less than a total of 1,000 francs although the price has risen to 3 francs per 100 !

Coste, whose guidance in this new development was all important, was originally a professor in the Collége de France who, in view of the exhaustion of the French oyster beds, was commissioned by Government about 1853 to investigate the oyster question and to report upon the advisability of employing artificial methods of regeneration ; especially was he to see whether the means which the Italians employed to propagate oysters in Lake Fusaro might not be applied in the French coastal lagoons. What he saw in Italy fired his enthusiasm ; he came back as the apostle of Italian methods and in glowing pages set forth the prosperity that was about to dawn on the French oyster culture industry. His description of the Lake Fusaro methods was read with avidity in every oyster depopulated locality ; many were convinced and within the next five years numerous experiments were in progress independently at various centres. The first trials of the new system consisted in the main of anchoring bundles of brushwood or fascines as spat-collectors over the bottom in suitable bays where a stock of parent oysters had been previously laid down. The earliest experiments carried out by de Bon at St. Servan at the mouth of the River Rance were a brilliant success giving within two years of the inception a revenue to the local fishermen of over 35,000 francs. Until the

year 1859 Coste however had not sought more than the restoration of prosperity to the old natural oyster beds, even his vivid and exuberant imagination had not realized the full possibilities possessed by methods of artificially collecting oyster spat; it was only when in this year he was sent by the Emperor Napoleon to Arcachon in response to urgent appeals for the favour of his expert judgment that this further import of his cultural methods was realized, and he perceived how in shallow bays, as that of Arcachon, the actual farming of oysters by hundreds of proprietors was easily within reach.

Coste recommended Government example in the first instance; he proposed the formation of two Imperial oyster parks to serve as model farms, to become at once public seed beds and establishments for the collection of spat in large quantities and for the trial of different forms of spat collectors.

After examination of the proposals the Government furnished the means to carry out this programme in its entirety. The chosen surfaces were carefully prepared and 100 cubic metres of cockle shells were spread in order to consolidate the bottom; 2 millions of stock oysters were imported and about 200 plank collectors installed. A body of watchmen were provided, housed on pontoons moored on the beds, and two guard ships were stationed in the bay. The results proved a brilliant success, an immense fall of spat was obtained alike on the collectors and on the imported stock and Coste sounded still louder his pæan of success "quel richesse pour la France, et quel enseignment pour les peuples!" Every one rushed to take up concessions. To people the parks thus opened over 10 millions of English and Spanish breeding oysters were imported in 1860 into Arcachon, and the same year the parkers sold 3 millions; the next year the sales rose to 8 millions of a gross value of about 240,000 francs and in 1862 the revenue attained the high figure of 376,000 francs. Prices all this time were high and the oyster farmers in their haste to become

rich were selling off their imported stock more rapidly than could be made good by the growth of the brood obtained by the yet imperfect form of collector employed. Several poor spatting seasons supervened, the parks became denuded by the reckless sale of breeding stock, there being an insufficiency of bred oysters to replace them ; depression and panic seized the smaller capitalists and concessions were thrown up wholesale. Be it noted particularly that the chief causes of this reverse were lack of foresight and the imperfect and expensive form of collector chiefly in use—the plank collector coated with a form of pitch or resin which, when separated from the planks, brought away the young oysters with it.

This disaster was a terrible set back to the young industry and no further progress was made till an unnamed seaman working on an oyster park near Granville suggested to his employer the advantage of utilizing half-round roofing tiles for the collection of spat. Coste heard of this, recognized its great possibilities and introduced the new method on an extensive scale at Arcachon. It answered admirably and proved far superior to the plank collector previously in use there ; immense quantities of spat adhered to the tiles laid out, but when they came to be detached it was found impossible to separate them without wholesale destruction. Even to break up the tiles and leave the young attached to fragments entailed great loss partly however compensated by the high price obtainable then for oysters ; a pause in development ensued till Dr. Kemmerer of the Ile de Ré overcame this difficulty by partly coating the tiles, before placing them in position, with a mixture of quicklime, sand and defibrinated blood to which he added broken shells and fragments of wood in order to increase the surface area. A little later he modified this procedure by interposing a sheet of paper between the tile and the layer of mortar. Then when the spat had attached, the whole covering of the tile, paper, mortar and spat, was detached with the greatest ease and sub-divided as required.

Ingenious as this was and successful when great care was exercised in its operation, it failed as a business proposition on account of the great amount of labour and time necessitated to render it successful. It remained for an ingenious Arcachon mason to interest himself in the subject and think out a simpler and more economical method. Michelet was this inventor's name and it is worthy of remembrance as by this and other of his practical devices oyster culture passed from the experimental stage into a settled and stable industry with a regular routine of work theoretically and economically sound. But simple though we know his final device to be it was only after severe disappointments suffered during the first two seasons (1863 and 1864) he engaged in these experiments that unqualified success crowned his efforts in 1865. Ignoring the details of his earlier attempts, we need note only that the final process which he invented was the covering of the tile with a friable coating of lime and sand in definite proportions mixed to a creamy consistence. Originally Michelet applied this to the surfaces of the tiles with a trowel ; later, the simplification of merely dipping the tiles into the composition made rather thinner was introduced.

The liming of tiles is to-day carried on exactly as Michelet perfected the process in 1865 and 1866, and tiles thus coated are to-day recognized as the only satisfactory form of spat collector suitable for the conditions prevailing in Arcachon basin.

Coste, whose genius does not seem to have been that of the inventor, was quick to see that the problem which, simple though it appeared, had baffled many intellects for several years, was at last solved satisfactorily; he hurried off to Arcachon and in his usual effusive manner wrung Michelet's hands the while he praised him, saying "I congratulate you most truly, for you have understood my ideas better than any one else." From this time we hear little of Coste and though it is to him in the first instance that the enormous oyster

industries of France and Holland owe their existence, yet France forgot him and he died in poverty and neglect.

Michelet henceforward devoted himself to the work of perfecting the details of local oyster culture ; by his process of liming the tiles used as collectors, when the brood oysters are large enough to be removed from the surfaces to which they adhere, instead of the little shells being injured in great numbers as in previous methods, the expert use of a chisel-shaped knife causes the little oysters to peel off with the flakes of crumbling mortar. By the little patch of lime which adheres in the hinge region these oysters are ever after readily distinguishable from those from natural beds.

Michelet completed his good work by devising "ambulances," which eventually developed into *caisses ostreophiles*, shallow boxes having frames filled in with wire-netting to serve as top and bottom respectively. In these "hospitals" as we may term them the brood oysters were left for some months before being laid out in *claires* or shallow rearing ponds and in separate hospitals were put all individuals that suffered injury during removal from the tiles, a process known in France as *détroquage*.

Thanks to these improvements, oyster culture underwent rapid development and expansion ; all abandoned concessions were reoccupied and many new ones were taken up ; the results of artificial spat collection by means of limed tiles in 1865 and 1866 proved this method a practical success and, in spite of a temporary check from 1867 to 1871 due to several exceptionally frosty winters and the distraction of war, the industry has steadily progressed till to-day practically the whole of the brood oysters reared and sold every year at Arcachon are the produce of the millions of adult oysters being reared and fattened in private parks. Throughout their whole life the 300,000,000 oysters annually produced at this centre live under control ; they are tended with continuous care ; they are shielded from enemies, the young or sickly go into crêches and convalescent homes,

the large and small are raked and cleaned as carefully as the flowers in any garden plot; all their life they live under artificial conditions and form perhaps the best and most perfected instance of what can be done by one of the youngest of the sciences—aquiculture, the cultivation of the economic products of the seas and of inland waters.

As a consequence of the continuous increase in the success obtained by the adoption of the new methods, the French Government in 1872 decided that their duties of tutelage might cease, the new industry having advanced to a degree of perfection which enabled it to walk alone for the future; accordingly they made over to the *Société central de sauvetage*, the French equivalent, I believe, of our National Life-boat Institution, the whole of the Government experimental oyster farms then containing more than three millions of tiles.

Thanks to millions of foreign oysters imported into the basin to furnish spat for culture purposes between 1859 and 1865, the old oyster beds in the channels and on unoccupied flats improved greatly; something of their former prosperity was eventually restored to them. The authorities, warned by the past, guarded these natural beds with the greatest rigour; fishing upon them was interdicted except on days and at the hours specified after an annual examination by a local commission of experts. Usually the fishing was limited to one or at the most two days per annum and all cultch and immature oysters had to be returned to the beds. From 1860 to 1872 these public beds or common grounds as we call them in England gave more than 80,000,000 oysters obtained partly by the dredge in the channels, partly by hand collection on the flats. In several years the value of the oysters fished amounted to over 150,000 francs.

From 1872 as oyster culture extended and became reduced gradually to an exact science with results surpassing the most optimistic anticipations, less and less attention was given to the fishery on the common grounds; this comparative neglect proved detrimental

to their well-being, mud began to accumulate and buried great quantities of oysters, weeds and other marine growths helped in the destruction, smothering the oysters or intercepting the food particles and entailing semi-starvation; finally the fouling of the valves with mud and sea growths prevented satisfactory spat falls. Thus the reproductive power of the beds was destroyed. The following table of the number of oysters fished from the common grounds from 1885–1900 shows the gradual deterioration of these beds, due be it noted not to over-fishing but rather from lack of the cleaning which *moderate* and *regular* fishing ensures. The figures should be compared with those in the table on the opposite page exhibiting the wonderful development of the *cultural* industry as apart from the unsown, unfarmed produce of the natural beds.

Produce of the Natural Oyster Beds in Arcachon Basin from 1885–1909.

Year.	Hours the fishery was open.	Quantities of oysters fished.		Value of the oysters fished.		Total value.
		By dredge.	By hand.	By dredge.	By hand.	
	Hrs.			*Francs.*	*Francs.*	*Francs.*
1885 ...	3	1,407,700	11,890,250	8,787	58,335	67,122
1887 ...	3	1,325,920	2,772,000	9,435	15,228	24.663
1890 ...	3	1,085,660	...	10,972	...	10,972
1893 ...	1	816,500	...	8,165	...	8,165
1895 ...	1 and 1½ respectively.	423,800	1,462,900	2,789	8,698	11,487
1898 ...	2	835,850	...	8,370	...	8,370
1900 ...	2	...	1,994,400	...	10,191	10,191
	Total ...	5,895,430	18,119,550	48,518	92,452	1,40,970

In view of this condition of affairs, the authorities in 1903, decided that the value of the open fishery had become so reduced and so little heeded by the local fisher community that it was not worth the expenses it entailed;

they accordingly decreed its suppression; no voice was raised in protest and at the present time the natural oyster beds in the basin are entirely ignored; all effort is concentrated upon oyster culture truly so-called. The following table exhibits in tabular form the statistics of the growth of this industry from the year when it commenced in reality.

Table illustrating the growth of the Arcachon Oyster Industry from 1859-1907 (after Boubés).

[*N.B.*—The figures relate to O. edulis alone.]

Year.	Number of oysters sold.	Value in francs.	Area cultivated in hectares.	Number of parks.	Average Number of oysters reared per hectare.	Average price per 1,000 in francs.
1859 ...	700,000	28,000	...	112	...	...
1860 ...	19,900,000	726,000	800	...	24,875	...
1861 ...	18,105,000	724,000	...	...	...	...
1862 ...	6,600,000	264,000	...	...	...	...
1863 ...	4,831,000	193,000	...	...	...	...
1864 ...	10,873,000	434,000	...	...	...	...
1865 ...	10,854,000	434,160	1,000	297	10,854	40
1866 ...	7,052,000	282,070	...	301	...	40
1867 ...	4,185,000	66,960	...	340	...	16
1868 ...	8,599,000	318,163	...	434	...	37
1869 ...	7,519,000	338,355	...	464	...	45
1870 ...	6,541,000	379,378	1,500	485	45,082	58
1871 ...	4,997,000	274,835	...	761	...	55
1872 ...	10,796,000	539,800	...	1,278	...	50
1873 ...	25,714,000	1,054,274	...	1,438	...	41
1874 ...	42,542,000	1,914,390	...	2,413	...	45
1875 ...	112,705,000	2,817,625	2,500	2,621	...	25
1876 ..	196,885,000	3,937,700	...	2,730	...	20
1877 ...	202,000,000	4,444,000	...	3,446	...	22
1878 ..	176,000,000	4,400,000	...	3,561	...	25
1879 ...	161,000,000	4,025,000	...	3,615	...	25
1880 ...	195,477,000	4,886,000	...	3,822	...	25
1881 ...	210,310,000	3,893,000	...	3,907	...	18
1882 ...	268,082,000	5,897,000	...	3,971	...	22
1883 ...	192,872,000	4,821,800	...	4,211	...	25
1884 ...	169,342,000	3,386,840	...	4,773	...	26
1885 ...	178,359,000	2,675,385	5,200	4,901	50,000	15

Table illustrating the growth of the Arcachon Oyster Industry from 1859-1907—continued.

[*N.B.*—The figures relate to O. edulis alone.]

Year.	Number of oysters sold.	Value in francs.	Area cultivated in hectares.	Number of parks.	Average Number of oysters reared per hectare.	Average price per 1,000 in francs.
1886 ...	236,276,000	2,835,240	4,015	...	...	12
1887 ...	212,427,000	3,186,405	4,111	...	...	25
1888 ...	236,982,000	3,105,660	4,200	4,235	49,296	20
1889 ...	247,463,000	3,727,455	4,500	4,500	55,355	16
1890 ...	258,067,000	3,503,305	4,700	4,384	49,700	14
1891 ...	373,613,000	4,489,438	5,000	5,699	66,710	12
1892 ...	540,283,000	6,466,000	4,700	5,778	110,060	19
1893 ...	442,955,000	6,209,325	3.800	5,887	108,935	14
1894 ...	424,726,000	5,620,870	3,444	6,020	119,609	13
1895 ...	446,986,000	4,022,874	3,348	5,824	135,535	13
1896 ...	582,880,000	4,463,040	3,354	5,891	173,790	11
1897 ...	398,693.000	3,701,930	3,342	5,901	119,299	10
1898 ...	319,772,500	2,807,983	3,311	5,901	96,579	11-50
1899 ...	299,484,000	2,898,828	3,301	5,923	90,722	10
1900 ...	318,890,000	3,708,304	3,247	5,867	98,232	11
1901 ...	291,255,000	3,616,539	3,375	5,879	84,333	12
1902 ...	311,544,000	3,425,861	3,400	5,943	91,630	9-75
1903 ...	299,550,000	3,786,215	3,250	6,750	92,541	10-50
1904 ...	75,684,000	675,021	3,615	6,617	22,160	11
1905 ...	420,000,000	3,380,000	3,095	6,006	135,705	12
1906 ...	261,344,000	1,577,310	3,424	4,580	76,325	16-50
1907 ...	352,557,000	2,659,460	2,833	3,895	124,448	13-25

The foregoing tabulation deals, as stated, solely with the product of the culture of the oyster indigenous to the coasts of France and England, *Ostrea edulis.* Of late years a formidable rival, the Portuguese oyster, *O. angulata*, has been largely laid down and cultivated in France ; its popularity and sales have been great and are increasing as it has the advantage of the native in everything save flavour ; it grows more rapidly, is larger, more robust in constitution, requires a minimum of care under cultivation, and finally, has enormous reproductive powers. The mass of the people who could not usually

afford to pay the prices asked for the indigenous product welcomed the Portuguese for its low price. Its mediocre flavour they willingly overlooked.

For a long time the oyster farmers of Arcachon, specialists in the culture of the home species, would have nothing to do with the Portuguese. They feared it, and made every endeavour to exclude it from the parks. Of late years, the increase of consumption has consisted almost entirely of the cheaper qualities; the cheap and tasty Portuguese was always sure of a ready sale, whereas the demand for the higher priced native was frequently so slow that the Arcachon oyster farmers found their stocks accumulating. In the end and against their will they had to go with the current and about 1901 began to cultivate the foreign species. In 1903 the first lots were put on the market, totally 2,740,000 of a value of 25,200 francs for the year. In 1906, the quantity sold was still small, only some $5\frac{1}{2}$ millions, but the next year, 1907, a sudden increase took place, no less than 95,760,000 being sold, a quantity exceeding one-fourth of the total number of natives sold in the same year, the value being 809,335 francs or nearly one-third of the total value of the sales of native oysters in the same period.*

IV.—PRESENT METHODS AND CONDITIONS.

(1) Tenure under which oyster farms are held; number and status of those engaged in the industry.

As is customary in civilized countries the law in France recognizes most clearly the exclusive right of the State to all land lying between tide-marks; in addition

* This would seem to exhibit the Portuguese as being sold at a higher price individually than the natives, a seeming contradiction of previous statements; the discrepancy is due to the fact that a great part of Arcachon natives are sold young for fattening whereas the Portuguese usually are sold only when of full edible size.

to such surface, land bare at low tide, the foreshore proper, it recognizes the state as sole proprietor of all submerged areas bathed by sea water whether in estuaries, bays, or the territorial water margining the coasts. In France this "maritime public domain" is considered inalienable; it may neither be sold nor otherwise disposed of. The State indeed is not the proprietor, being rather the custodian of what is and must remain a possession reserved for the public benefit. So far as possible the nationals of the State should have free usage of it but no user under ordinary conditions may possess special right over another or exclude others from the usage or access he himself is allowed.

However, temporary and privileged occupation is conceded under special circumstances on payment of an annual rental to compensate the public at large for deprivation of the right of free access and usage of the area so occupied.

During the period when oyster culture was passing through its experimental stages, the State, to favour the infancy of the industry, gave these concessions free under the stipulation that the concessionaires should be either naval reservists or be working in partnership with one or more of such privileged class.

This system lasted till 1873, when it was decreed that naval reservists alone should have the privilege of free oyster farms; all others were forced to pay the rentals assessed by Government officers.

At the present time no rent-free concessions exist except a few held by the original concessionaires under the old regulations; from all other occupiers of oyster parks in the maritime public domain, annual rentals are exacted varying in accordance with the situation of the ground. Those parks occupying positions considered the most favourable for oyster spatting and growth are charged 54 francs per hectare (= about Rs. 13 per acre); those in the second category, 45 francs (Rs. 11 per acre), while the third and least suitable grounds pay 36 francs per hectare (Rs. 9 per acre). Preference is

still given to naval reservists as they or the widows of such men have the first claim on any oyster ground that may be abandoned or on any area hitherto unoccupied. Only in default of an application from a reservist or a reservist's widow may any outsider obtain a concession—even then, naval and military pensioners have preference, and after then civil pensioners, and non-pensioned soldiers and officials; those outside these categories come last and even then, it is laid down that preference shall be given to those whose past conduct promises best for the management of the concession.

As is usual in State matters in France a great number of formalities have to be gone through when applying for a concession. In actuality no unreasonable difficulties appear to be placed in the way of applicants; the administration is paternal, if formal; indeed I believe the authorities ignore the provisions of many of the older laws which deal with oyster fishing and which were made before the development of oyster culture was dreamed of, for if enforced these would be the occasion of much hardship and loss to the concessionaires. Such laws as are out of date should of course be abrogated or amended; the license holders should not be at the mercy of official benevolence and be liable at law to severe pains and penalties for acts which are not offences under the changed conditions which now prevail. Some day no doubt the many laws relating to oyster fishery and culture will be consolidated and brought up to date; meanwhile the local officials who understand what is justifiable and what is not in the conduct of oyster parks enforce what regulations they think should be upheld and forget the existence of the others—an anomalous position for the administration; La Gironde however is a department where the people are endowed with more than the average of sober common-sense—witness their action in the Great Revolution—and the discrepancy between the precept and the practice of the law disturbs no one but the critical jurist.

Free sale of a concession is nominally interdicted by the law; a concession of a portion of the public domain may be resumed at any time by the State and no prescriptive right can be claimed in it as it is inalienable by the State. In practice, the local administration permits a concessionaire to cede his park to another provided the price paid comprises only the value of the cultural equipment *plus* the value of the labour expended in improving the ground and fitting it for the purposes of oyster culture. As a matter of fact this rule is evaded and might as well be abrogated; it leads frequently to duplicity—one price is named in the contract offered for official approval, another, the real one, is arranged privately between the parties; all the law can do is to render illegal any suit in the courts for payment of the additional price stipulated for in the secret contract.

In 1908 out of a total shore-dwelling population of about 30,000 distributed in the towns and villages along the margin of Arcachon basin, not less than one-third (10,000 to 11,000) are more or less dependent on oyster culture for their living. The greater number of the fishermen own one or more oyster parks and are practically all enrolled for active service in the fleet if required, *i.e.*, are *inscrits maritimes*; of these concessionaires there were 1,123 in 1908, the remainder of lessees of all classes numbering 562, a total of 1,685, who owned between them the 3,895 parks occupied in that year in the Arcachon basin. The area covered by these 3,895 concessions aggregated 2,833 hectares representing an average of 1·375 hectare or about 3½ acres each. From this fact and from the status of the majority of the holders, it is obvious that small holdings are the rule; indeed the capitalist concessionaire who exploits large oyster parks entirely through hired labour is a rarity and invariably belongs to the district. No outside capital is present and the joint stock company is neither known nor required.

In Arcachon, as in France generally, oyster culture is an industry of small holdings worked as far as possible

by the labour of the holder and his family. The operations are varied, and several are such as may be carried on by the older children; the wife looks after most of the operations on the park itself, raking and re-arranging the oysters each low tide; she also helps in the liming of the tiles, sees to the separation of the brood oysters from the tile-collectors and gathers and prepares the oysters for sale. Incidentally she is the family treasurer and usually has to be consulted in all money transactions. The children assist their mother according to their ability, in their early years cleaning tiles and washing the oysters and gradually relieving the parents as they grow up.

Cultural operations are in the main carried on by female labour, the men being called upon chiefly for the heavier work, such as the transport of tiles to the parks, the fixing and packing of the collectors and the repair and renewal of the fences and enclosures. The duties of which women and children are capable although intermittent continue more or less the year round; those requiring the labour of men are seasonal and of limited duration. Hence while oyster culture is the sole or principal occupation of some parkers, for many, probably the majority, it constitutes a supplementary calling, seeing that the bulk of the work can be carried on by the family and that the actual labour on the park is possible only at low tide. At high tide and when the weather is stormy the parker is comparatively free and may and usually does carry on another trade. The bulk of the parkers are fishermen and with the recent and sudden development of a great sardine industry at Arcachon, most of the parkers are engaged in this fishery—indeed in view of the poor prices for oysters prevailing of late years a number of parkers sold off their stocks and, whenever possible, their concession rights as well in 1907–1909 to obtain money to purchase the motor driven boats essential to a profitable prosecution of the new fishery. Many were unable to find buyers for their rights apart from their stock and in such cases

abandoned them, one of the chief causes leading to a reduction of the number of parks in operation in 1909.

We see then that at Arcachon where the condition and conduct of oyster farming are typical of the course of the industry in other districts, small holdings are the rule; the aim of the French administration is and always has been to facilitate the acquisition and operation of oyster parks by men of small means and preferably those whose services are earmarked for service in the fleet for defence of the country or who have already performed such service. In no other country does such consideration and foresight exist; in almost all others the State's right to the littoral is at the disposition of the highest bidder and no safeguards there exist to prevent capitalists from adding park to park till they control the whole industry of the district and paralyse the initiative of men of limited means. In England, Holland, Portugal, and Germany the oyster industry has the same story to tell; how wealthy companies and corporations control the beds and culture grounds and how the man who in France would be an independent and free unit knowing no master but the needs of his family, is replaced by the hired labourer, who, usually with no interest beyond his daily wage in the prosperity of the work he is engaged upon, obeys orders and has the feelings and faults of the man living in dependence upon the favour of a master.

(2) Outline of the routine of oyster-culture; definition of terms.

In spring the preparation of the tiles which will be used in June and July for the collection of spat—the free swimming larvæ of the oyster—is taken in hand in the intervals of household duties or of more pressing work. First the tiles are cleaned and then are limed, a process known as *chaulage,* work generally done by women or by girls. On their part the men see to the repair of the collector cases which are destined to receive the limed tiles. Every year the cases receive a fresh coat of coal tar but this is usually a special trade,

the cases being given out to be tarred on contract. As soon as examination of adult oysters shows that spawning will take place before long, the clean limed tiles are transported to the parks. Flat bottomed barges specially built for this purpose are employed by the more prosperous cultivators, but the majority are content to use the little boats (*pinasses*) they use in fishing and ferryage to and from the parks. With the great development of motor boats that has taken place since 1906, those who can afford such, employ a motor pinasse as a tug, and a string of small boats laden with limed tiles in tow of a palpitating motor-launch is an every day sight during June and July. Then ensues a busy time in the placing in position and securing of the *ruches*, crate-like cases into which when ready the limed tiles are packed. This work is finished in normal years by the middle of July—often indeed by the end of June. From then till the month of October the women and older girls of the family are capable of tending the daily well-being of the oysters in stock, re-spreading and raking and cleaning up generally. If need be the men in their spare time do any needful repairs to the protective devices employed in the park against enemies, fishes chiefly.

Towards the end of September and during the month of October a considerable amount of attention is given by careful cultivators to the cleaning of the spat-covered tiles; they gently brush the brood oysters, now about 3 months old, to detach any living growths—seaweeds, ascidians, sponges and the like.

During winter the routine work of cleaning and raking goes on in fine weather together with the transport ashore and preparation of such fully grown oysters as may be disposed of.

Détroquage, the harvesting of the brood crop, takes place in the early part of the year. This is separation of the brood oysters from the tiles and is carried out during the first favourable spell of fine weather when the growth of the young oysters is seen to have progressed sufficiently. Under very favourable

conditions it may take place as early as January but the height of the détroquage season may be said to be in March and April. When this operation is decided upon, all hands have to take part. The husband transports the tiles to his oyster-shed ashore, the wife, if possible, takes charge of the further operations. With the aid of the children if available, or if not, with hired female help, she sees to the stripping from the tiles of the young oysters now about one inch in diameter.

After separation from the tiles the oysters are washed, cleaned, and classed into two sizes, those damaged in the process of stripping being kept apart from the others.

All are then transported back to the park and so far as the means of the cultivator permit are put into oyster cases called *caisses ostréophiles* or *ambulances* (hospitals) where they stay till they are sufficiently grown to withstand most of the dangers they will experience when spread over the open surface of the park. In order to raise large numbers upon a limited area, constant attention has therefore to be given to raking and re-spreading and cleaning. A rough tide heaps the oysters along the leeward side of the park fencing and if not re-spread much loss would occur. For this reason also the fences and borders of the parks require constant supervision, both to keep out enemies and to keep in the oysters.

Under the regulations governing oyster-culture at Arcachon, no oyster may be exported under 5 centimetres (two inches) in diameter. This size is reached usually in from 18 months to 2 years time, when the oyster farmer usually sells off the greater part of his stock to make room for the new lot of young oysters he has secured upon his spat-collectors. Some cultivators keep a portion of their stock another 6 to 12 months before selling, although the mortality is considerable during this interval—prices at the age of 2½ and 3 years being naturally much higher than when the oyster is but 18 months old.

Few cultivators rear their oysters to a size at which they may go into consumption, as Arcachon is not so well suited to this phase of the industry as many other oyster centres; for instance an oyster sold at two years old to a Marennes culturist and farmed for one year in its new abode is of a size of shell and flesh at the end of this time such as is attained at Arcachon only at the end of four and even five years of age. For this reason the bulk of the culture at Arcachon limits itself to what is termed *demi-élevage*, the production of brood oysters and their care till old enough to sell to oyster farmers whose parks are more favourably situated for fattening.

A noteworthy feature in the regulations governing oyster culture at Arcachon is the prohibition which exists against the sale of any oysters between 15th May and 1st September, a regulation which is a grievance and a hardship to many parkers, but which is enforced with a view to obviate any danger which might otherwise accrue to the industry were there to be any great depletion of the stock of mature oysters during the spatting season.

(3) Detailed Description of Cultural Operations.

(*a*) *Selection of suitable culture ground and the preparation of the surface of the park.*

One of the chief characteristics of the Arcachon basin is the extreme variability in cultural value of the ebb-dry flats whereon oyster farming is conducted. Three factors conduce to this, the nature of the soil, the salinity of the laving water, and the degree of current wash experienced. This fact is also recognized by the administration which grades the parks into three classes paying annual rentals proportionate to the assessed value from a cultural standpoint, 54, 45 and 36 francs respectively per hectare. Quite often one side or one corner even of a small flat may be specially adapted for the collection of spat while the side or corner opposite may be of little or no value.

Ground most suitable for the collection of spat is usually found wherever a strong current courses along the margin of a flat or *crassat*. Wherever such a scour is specially well marked, collectors there placed keep clean and free from glairy sediment and so present suitable surfaces for spat attachment; this appears to me the special virtue of this position. Usually the location for the crate-like collector cases solely employed at Arcachon has a soft mud bottom, so soft that the parkers wear wooden plates attached to the feet to prevent sinking too deeply. This bottom requires no preparation other than the driving in of six short piles to serve as a foundation for each collector-crate which it is intended to install. Each pile is driven from 2 to 3 feet into the mud, its upper end projecting a few inches above the surface.

For rearing the brood oysters after stripping from the tiles, the higher and central portions of the flats are best adapted whenever the surface is firm and not excessively muddy. At the present day practically all the suitable lots have long been in occupation and are now in prime condition. Prior to the advent of culture and when natural oyster beds still flourished in the basin, the greater proportion of these flats were occupied by oysters forming extensive areas of hard well-consolidated surface from the long continued accumulation of the dead shells of former generations. The reckless and unrestrained exploitation that occurred during the first half of last century gradually reduced the thickness of this stratum of hard material; the dead and living shells forming the bed were the only cultch for spat to attach to, and with the inroads made on the bank every year so large an amount of this natural cultch was removed ashore and never replaced that the surface of the flats suffered appreciable degradation and very great deterioration from a cultural standpoint. To improve the areas selected by Coste as "State model farms" large quantities of cockle shells were spread over the surface to help to consolidate it. Fortunately however it was found that if

care be exercised in working the park, the muddy or rather clayey sand forming the upper surface and core of the best flats is sufficiently consolidated to require little or no artificial aid to constitute it suitable to bear a load of growing oysters. In practice the parker takes care that the oysters are frequently raked to the surface when the ground is rather soft; the workers also take precautions to avoid trampling the oysters into the mud, having plate attachments to their shoes under such circumstances. For rearing brood to the size of 2 to $2\frac{1}{4}$ inches in diameter the ebb-dry flats of the central and south sections of the basin are used; those of the north and west are too muddy to be of value while those along the western shore of the basin and towards the seaward passage where the salinity of the water is appreciably higher, form a separate class limited in area and number and are devoted almost entirly to the purposes of fattening.

The whole of the western shore of the basin is sandy, a long narrow dune-formed peninsula separating the basin from the sea. A century ago it would have been madness to form parks along its landward margin as the prevailing westerly winds were at that time moving the dunes eastwards, constantly invading the littoral. To-day the march of the dunes has been arrested by planting them up with forests of pine trees; the oyster-farmer may now in comparative security possess himself of the littoral, fence it in and prepare it for oyster culture. Along the sandy margin especially in the section towards Cape Ferret, the headland which forms the northern bound of the passage seawards, oysters are found to thrive and fatten very much more rapidly than on the sections more remote from the sea. In consequence it pays the parker to incur much heavier capital expenditure in clearing and preparing the ground here than elsewhere. And much has to be done, for here no level flat exists, but a long sloping foreshore covered with banks of arid sand unsuitable on account of its loose and shifting nature to form park bottom. It happens

however that a firm and well consolidated surface somewhat akin to that forming the core of the central flats is found beneath the masses of sand which westerly winds have piled upon the littoral. As is to be expected this substratum contains a larger proportion of sand and smaller quantity of mud than is found in its parallel layer on the flats. To form a park on the littoral of the Cape Ferret peninsula, the stiff substratum has to be exposed by the laborious and costly removal of the overlying sand, a work to be faced only by those who can afford to incur such heavy capital expenditure. The work has been faced in thorough fashion; hopper barges have been built capable of loading large quantities of sand and to facilitate disposal of the spoil, drop-doors of primitive but effective pattern are fitted in the bottom. At one end a little cabin is provided for the accommodation of the workpeople (Plate 1, figure 8). Parks formed in this manner are esteemed most highly, and some have changed hands at as much as 40,000 francs per hectare while the proprietor of one which I inspected informed me that he would not sell his under 50,000 francs the hectare; at this he would even be loth to sell as on the one hand the cost of bringing the ground into working order is very heavy and on the other the value of parks such as this for rapidly rearing and fattening oysters is correspondingly high.

(*b*) *The form and preparation of the Collectors.*

The tiles employed at Arcachon as spat collectors are large and massive, markedly convex along their length. The pattern is the same as that of the so-called "country tiles" in ordinary use in India, but of larger dimensions. That in use at Arcachon is the "Gironde" tile, a variety longer, broader, and thicker than the ordinary pattern employed for roofing purposes, characteristics which experience has demonstrated to render this pattern more suitable for oyster culture where strength is a chief desideratum.

The accepted dimensions are, length 20 inches, width at the wide end 7 inches, at the narrow end 5 inches. The concave side is purposely left rough and uneven with the sand of the mould still adhering, while the upper or convex surface is smoothed by hand in the usual way. They are very hard, well baked tiles and their weight and strength permit of considerable rough usage with comparative impunity; annual loss from breakage is nevertheless heavy and has to be reckoned as one of the annually recurring expenses to be faced. Under ordinary circumstances the annual loss of tiles through breakage and other causes cannot be reckoned at less than from 10 to 15 per cent. The cost varies according to the demand between 45 to 50 francs (Rs. 27 to 30) per 1,000.

To prepare the tiles in the manner most suitable to ensure a satisfactory settlement upon their surfaces of the oyster larvæ when in the free-swimming stage, they have to receive if new an initial wash of pure lime and then upon this a coating of mortar; if the tiles have been previously used no lime wash is again necessary, it suffices to coat with mortar alone. This process of liming (*chaulage*) is carried out usually by women. A hogshead or large barrel is used as a mixing tub. The mixture used in giving the preparatory coating to new tiles is simply whitewash made rather thin, pure lime mixed with water to a thin creamy condition and only sufficiently thick to leave quite a thin even wash on both surfaces of the tiles after they are dipped into the mixture. The second coating, unlike the first, must be repeated annually. The mixture employed remains the same as that introduced by Michelet in 1865, modified in the relative proportion of the components, lime and sand, according to the individual opinion of the user. The standard composition as given in works dealing with oyster culture in France is always given as 1 of lime to 2 of sand. Practice is variable and while some use the standard proportions, others increase the ratio of the lime and a few that of the sand. Mr. Louis Michelet, who, as the son of the inventor, has special claim

to attention, believes that two parts of lime to one of sand give a deposit of ideal friability, a coating which flakes off in the most satisfactory manner when the time comes to detach it from the tile with the oysters adherent to it. When more sand than 2 to 1 of lime is employed, the coating is liable to become too hard and in flaking it from the tiles such violence has to be used that too great a proportion of wounded oysters results. On the other hand, a mixture containing a high percentage of sand appeals to the economical spirit of the poorer oyster culturists as lime costs about Rs. 17 per cubic metre against sand which may be had close at hand for the labour of transport. Hence we have such variations in the proportions used as equal parts of lime and sand; $\frac{1}{3}$ lime, $\frac{2}{3}$ sand; $\frac{2}{3}$ lime, $\frac{1}{3}$ sand; at the extreme of the scale we have men using 3 of lime to 1 of sand and others 1 of lime to 3 of sand! Where lime is readily procurable at a low cost and when the industry is flourishing probably $\frac{2}{3}$ lime to $\frac{1}{3}$ sand is the proportion most satisfactory but when conditions are such that every small economy is of importance, as would be the case in India then a reversal of the ratio ($\frac{1}{3}$ lime, $\frac{2}{3}$ sand) is most likely to prove preferable. In this proportion a cubic metre of quicklime and two cubic metres of sand when mixed to a proper consistence is reckoned to be sufficient to coat 12,000 tiles.

This coating of mortar was originally applied by Michelet (who was a mason by trade) by hand, much as a mason lays a layer of mortar preparatory to placing another brick or stone. This was found too tardy a method and it was seen that if the mortar were made more fluid a satisfactory coating could be obtained by dipping the tiles into the mixture. Figure 10, Plate II., shows the process in typical operation. Here husband and wife are seen busy liming a large quantity of tiles; between them stands a barrel three parts full of a mixture of sand and lime stirred to the consistence of thin creamy mortar. In this particular instance 1 part of lime to 2 parts of sand was the proportion employed.

To counteract the tendency of the sand to separate out and settle to the bottom of the barrel it is stirred up frequently with a short-handled oar-shaped stirrer (Figure 2). Long-handled iron pinchers are employed

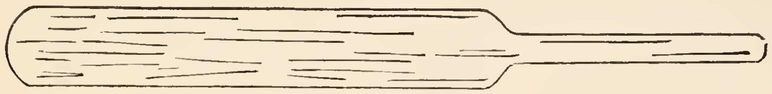

FIG. 2.—LIME STIRRER.

to hold the tile while being immersed. The tile is taken up by one edge, convex surface upwards, and in this position it is immersed in the mortar; by a turn of the wrist the tile is twisted concave side up as it is withdrawn after a momentary sojourn in the mixture. As the tiles are limed they are neatly piled in stacks, the concave surface upward in all cases, in order that the coating on this, the important surface, shall not drain away as it might if stacked in the reverse manner. The coating applied should be smooth and even with a thickness about equal to that of a half anna piece.

A fact mentioned to me by M. L. Michelet is that a lime containing a proportion of clay (burnt) is of superior value to pure lime; it appears that this admixture gives it a superior setting quality, and renders it more resistant to water.

Liming operations are invariably carried out ashore in the workyard adjoining the wooden store-cabin which every parker possesses in some convenient spot close to the beach and where he stores implements and materials not in use (Plate I, figure 9).

(*c*) *Installation of the Collectors; their oversight while in place.*

In many of the localities where the Portuguese oyster is under cultivation in France as also almost universally on Dutch oyster grounds, no special case to

contain the collector tiles is used. In Holland, in the east arm of the river Scheldt, between 10 and 15 millions of limed tiles are laid down each year and the whole of this number are simply piled on their edges, concave surface downwards, in long parallel rows on the tidal flats where the surface is stiff and well consolidated and fairly free from the evils of soft mud and shifting sand. At Arcachon conditions are not so favourable; the best situations there for spat collection are the abruptly sloping margins of those flats in the central and eastern sections of the basin washed by strong currents for a certain period each tide and these places are almost all characterised by a soft muddy surface a foot or more in depth. These local conditions have two results, they limit greatly the horizontal area available for spat collection and they render necessary some device to elevate the tile collectors above the mud. Vertical instead of horizontal piling of tiles therefore takes place and to permit of this being done economically and with safety from the violence of wind, waves and currents, a crate-like case of wood has been devised to contain the collector tile. The tile-crate or *rûche* as it is called in France from its resemblance when filled to honeycomb is made of a size to contain one hundred tiles. The overall dimensions of a *rûche* are 2 metres long, 60 cms. wide and 60 cms. high ($6\frac{1}{2}$ ft. by 2 ft. by 2 ft.). The bottom frame consists of four roughly sawn pine bars nailed together with a single transverse strengthening batten at the mid-length thus:—

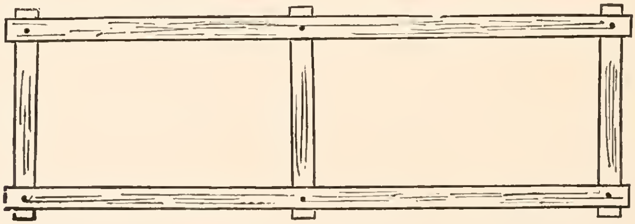

Fig. 3.—Bottom Frame of a Ruche.

The upper frame is similar. To join the two frames into a crate vertical battens $2\frac{1}{2}$ inches wide are nailed on, eleven along each side and 2 at each end thus :—

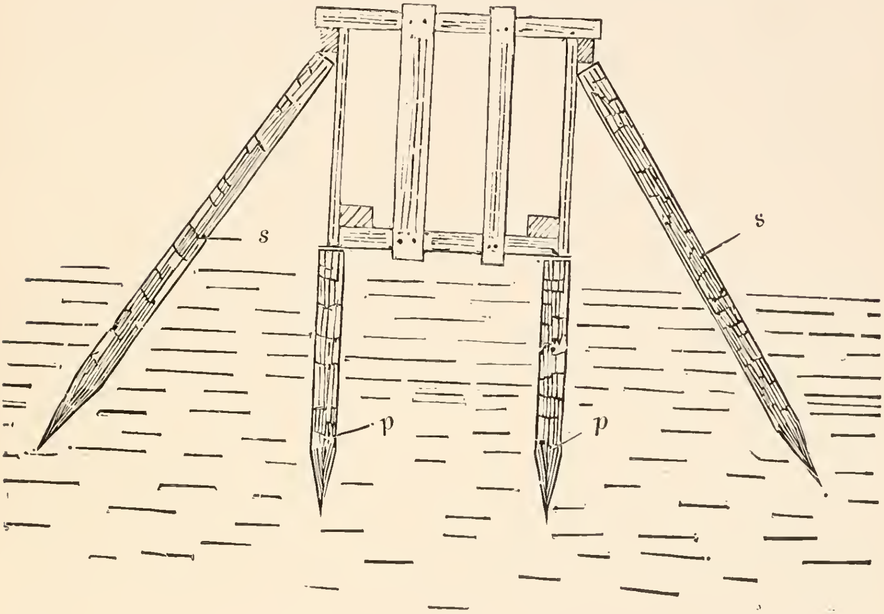

FIG. 4.—END VIEW OF A RUCHE TO SHOW DETAILS OF CONSTRUCTION.

p. Piles driven into the Mud to give a firm Foundation ;

s. Side Props or Stays.

It will be noted as a useful detail in construction that the side battens are nailed upon the outer side of the rectangular lower frame but upon the inner side of the upper frame ; this permits the ends of the tiles in the bottom row (laid transversely) to rest upon the side bars of the lower frame, while the side bars of the top frame serve to give purchase to buttressing stakes. The ruches are bought ready made from local carpenters and cost, tarred ready for use, exactly one rupee each at the factory. The life of a ruche is three to four years ; each year the repair and preparation of the old ruches occupies a good deal of the parkers' time and attention—they

must first be cleaned and repaired and then be given a fresh coating of coal-tar. These operations should be done some time in advance of the spatting season to allow of the tarred cases being well soaked before the limed tiles are put in; parkers have lost their harvest through inattention to this simple precaution, the freshly-tarred cases giving off such odour and noxious compounds as either hindered spat attachment or killed the spat soon after settlement.

To secure good results it is essential that the collectors be not placed in position any considerable length of time prior to the general spatting of the adult oysters in the parks in the vicinity; if they be put down even a fortnight too early a glairy film composed partly of mud and partly of microscopic plant life (diatoms and other algæ) forms on the surfaces of the tiles. On this slimy surface oyster larvæ find no foothold; they pass away and are lost to the parker who has thus prematurely immersed his collectors. The date of emission of spat by the mother oysters is usually deduced with approximate accuracy from the colour and appearance of the gills. Sample oysters are opened from time to time. As soon as the gills take on a dark blue-black colouration the parker knows that no time must be lost in putting his collectors in place. With a continuance of fine warm weather at this season spatting takes place very soon after but should inclement weather supervene in the interval, spatting may be retarded a fortnight or even longer.

As soon then as the signs of early spatting are observed, all haste is made to transport the limed collectors and the necessary number of ruches to the park. Pinasses and flats are loaded up and despatched soon after high water on the first day that the tide recedes sufficiently to permit of work being done at the parks. With the advent of the motor boat, this transport of tiles has been greatly facilitated and now if the parker has no motor pinasse of his own he usually hires one to

tow his barges (Pl. II., fig. 11) to his concession, a great economy both of time and labour. If the bottom be firm and well consolidated the weight of tiles within is sufficient to keep the ruche in position. More frequently the ground chosen is soft and muddy and piles have to be driven well down to form a foundation for the ruche and prevent it sinking partially into the mud. For each ruche usually 6 piles are used, driven in until the upper ends are a few inches above the surface of the mud. On these the ruche is placed and securely nailed thereto. To obtain further rigidity should the mud be specially soft or the position somewhat exposed, side stays or struts are used to give support (Fig. 4). The struts are pine props driven by hand into the mud obliquely for some 2 feet or more and so placed that the upper edge of the ruche rests upon them ; a nail driven through the ruche frame into the head of the prop prevents displacement.

The ruches are disposed at right angles to the margin of the channel they border as this interferes with the current more effectually than in any other disposition ; eddies and quiet waters are the consequence and such by delaying the current-driven spat give greater opportunity for it to settle and attach upon the tiles. According to the width of the ground available, the ruches are arranged in two or in three rows ; between each two rows sufficient space is left for a man to pass.

In stacking the tiles in the ruches, the lowermost row is laid transversely, the ends of each tile supported upon the longitudinal bars of the bottom frame of the ruche (Pl. III, fig. 12), which is made of a size into which the tiles just fit comfortably when laid transverse to the length of the case. Care is taken not to allow adjoining tiles to touch one another ; a space of from 3 to 4 centimetres is given between them. Nine tiles go usually to form a transverse row. The remainder of the tiles are laid in rows alternately longitudinal and transverse, the concave surface always downwards. A ruche of the usual size accommodates 100 tiles.

When the last row has been placed a quantity of brushwood or pine branches are laid over the stack of tiles and secured by cross battens nailed to each edge of the case (Pl. III, fig. 13). This serves excellently as an elastic packing to keep the tiles at once firmly in place and to prevent them being broken or damaged by rubbing or jarring against one another during rough weather; it has the further advantage of protecting the young oysters after their settlement on the tiles from the intensity of the sun's heat—a danger not to be neglected.

Under normal fine weather conditions when the spring has been genial and warm, spatting takes place during the last fortnight in June; collectors are then placed as early as 12th June. The summer of last year was unusually chill and bleak and in consequence few collectors were put in position during June; even in the first week of July the liming of tiles was still proceeding and many parkers did not lay out their collectors till well on in that month (Pl. IV, fig. 14).

When all collectors have been laid in position they should receive careful attention every few tides; every effort has to be made to keep them clean and free from any muddy deposit while they await the arrival of the spat; if this be delayed at all, means should be taken to rinse off the sediment which gathers—the plan in use at Arcachon is the primitive one of dashing water among the tiles by means of a long handled wooden ladle, a similar method to that employed in the town in the watering of the streets. As much violence is used as possible, but it struck me at once how much more effective would be the use of a garden syringe and a short length of hose. Some years this danger of the muddying of the tiles is much greater than others, the amount of mud held in suspension in the water depending on tidal conditions and on the rainfall and weather prevailing at the particular season.

When once the spat has attached in quantity the constant attention hitherto given is no longer necessary;

it suffices if the collectors be carefully examined after any spell of stormy weather. It is also essential to the well-being of the young oysters that when they have attained an approximate age of three months, the whole of the tiles should be gone over most thoroughly and all sea-growth other than oysters brushed off. The proper observance of this precaution which all careful cultivators practise, accelerates the growth of the young oysters in a marvellous manner, Monsieur Michelet informed me ; the best way to carry out the cleansing is first to crush all the objectionable growth, which consists largely of ascidians, by means of a pad of sacking and then to remove the debris with the aid of a stiff brush. The employment of the pad makes the rubbish more readily detachable ; without it greater force has to be used entailing a danger of damaging or brushing off some of the young oysters.

Some parkers do not take the trouble to perform this cleansing process and their oysters in consequence show almost no increase in size for the remainder of the time they remain on the tiles ; the extra trouble and expense of the cleansing is amply repaid by the higher value the product possesses when the time comes for detachment from the collectors.

(*d*) *Détroquage, the separation of brood-oysters from the Collectors.*

Détroquage, the detachment of brood-oysters from the tile collectors, is carried out as early as the weather will permit in the year following the attachment of the spat. In mild winters it may begin as early as January or February, but it takes place more usually during March and April when the young oysters are about 9 months old. Exceptionally it may have to be postponed till May if the season has been very inclement and development greatly retarded. If the tiles have been

kept clean and free from competing or smothering growths, ascidians, sponges, mussels, and sea-weeds, the spat should now measure about an inch in diameter (2–3 cms.); their shell should have acquired sufficient strength to permit it to sustain life in a non-attached condition. After a good spatting season 150 young oysters is a fair average per tile; in very unfavourable years the average may drop to 15-20 per tile, an occurrence which fortunately does not take place more than twice in every ten years' cycle.

Détroquage, a word which it is convenient to adopt from the French as we have no suitable equivalent in English, is carried on ashore in the parker's workyard, ruches being dismantled and the tiles being brought ashore in instalments as the work progresses.

Thanks to the imperfect adhesion induced by long immersion in the sea and the presence of the preliminary wash of pure lime, the coating of mortar may now be flaked off in fragments from the tiles with the greatest ease, each flake carrying with it whatever young oysters happen to adhere at that point. A series of sharp blows and thrusts delivered by means of a chisel or spatula-shaped knife suffice to loosen and detach the mortar coating and its burden from a tile—the operation occupying on an average a little more than a minute. The work is easily learned and is not exhausting. It requires exactly that quality of carefulness and attention for which female labour is well adapted; as a consequence it is entrusted largely to women and girls. While engaged in detaching the small oysters the workers are grouped round wooden stripping tables having a high edge along each side; in the centre is a large opening towards which the bottom slopes on all sides and through which the flakes of mortar and young oysters drop into a wooden tray placed there to receive them. As a rule the tables are square-topped and of a size convenient for four strippers to work at each, two and two on opposite sides, leaving the other opposed sides free.

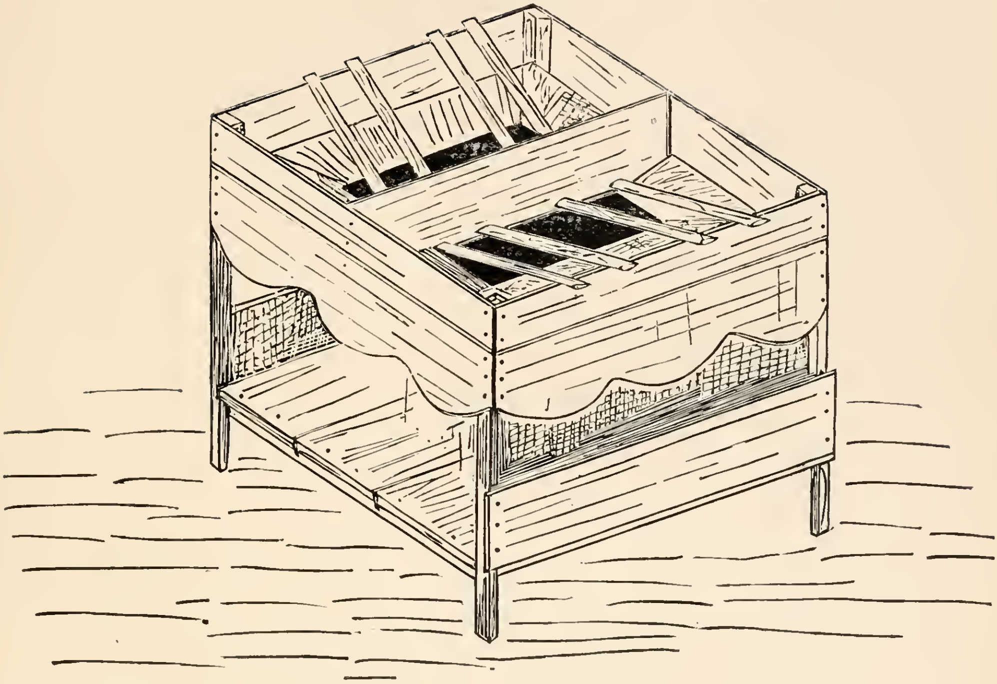

Fig. 5.—A detroquage table.

To steady the tile while being handled, two guide bars sloping from the edge of the bin-like table to the lower edge of a central transverse partition are nailed on in each worker's place, or four pairs in all. (See fig. 5.) Each worker in a 7 hours day is expected to strip 200 tiles and also to wash the young oysters flaked from these tiles. The oysters are then temporarily placed, still in wooden trays fitted with wire netting bottoms, in the storage tank which is an essential portion of the equipment of a parker's working head-quarters ashore.

As soon as time permits, the young oysters are taken out, cleaned, and classed, with the aid of sieves having meshes of 1 centimetre diameter, into two grades, those measuring one centimetre and under, and those of superior size. Oysters damaged in the process of detachment are also picked out to be kept apart from their sound

companions. The percentage of these last is however trifling when reasonable care be exercised in the stripping process.

When détroquage is completed, the tiles, denuded of their coating of mortar, are washed and stacked in heaps to await the approach of the ensuing spatting season when they will be again limed and placed along the margin of the channels to attract a fresh generation of oyster spat. The ruches next demand attention; considerable damage is unavoidable every season and this must be made good and the cases thoroughly retarred by a dip in a cauldron of coal-tar, before they may be employed again.

(*c*) *Rearing to saleable size.*

As soon as possible after détroquage the brood-oysters are conveyed back to the park and placed in shallow protecting cases, called *ambulances* or *caisses ostrèophiles*. These "hospitals" as we may term them in English are simply large shallow boxes each formed of a skeleton wooden frame 2 metres long by 1 metre wide and divided into two or more usually three compartments. The bottom is closed in by a sheet of galvanized wire netting and for cover a second frame also covered with wire netting is employed. The depth of the case is not more than 6 inches. To allow water to circulate freely through the case as well as to secure it from displacement by the waves, the sides are nailed at a height of 3 or 4 inches from the ground to 4 posts driven well down into the soil (Pl. IV, fig. 15).

An oyster case of the usual dimensions will accommodate from 12,000 to 15,000 brood-oysters at the time they are stripped from the tiles; as growth proceeds the numbers have to be thinned by transference of a quantity to other cases or to the claires or to the open ground of the park.

The employment of these cases is of vital importance to the culturist during the period immediately following

détroquage. By their use the brood-oysters damaged during this operation and those whose growth on the tiles has been retarded through crowding, unfavourable situation or the juxtaposition of competing organisms (mussels, ascidians, barnacles, etc.) experience improved conditions and at once respond by immediate increase in the rate of shell growth. The construction of the case and the manner it is raised above the ground enable the young oysters to experience the full benefit of the water movement set up by the action of the tides ; the current passes not only over them as when they lie free upon the surface of the park, but also beneath and betwixt them, hurrying food to every gaping mouth. Danger from partial suffocation by mud, and from the ravages of enemies, whereof the name is legion when the oysters are young, are largely eliminated automatically by the form and position of the cases ; the parker also contributes much to this immunity by constant attention to the well-being of the contents. As frequently as possible he visits the cases, clears away whatever sea-weeds and rubbish may have attached to or lodged within the cases, washes off mud, and, most important item of all, rearranges and relevels the brood-oysters themselves, that all in turn may have the advantages of forming a portion of the uppermost layers. Here I must mention that economy forbids the oysters to be spread thinly in the cases. When quite young they are often disposed quite three inches in depth ; only by constant visits to turn and rearrange the dense mass can health and rapid growth be ensured. The advantages of case-culture are so emphatic in ensuring rapid growth and so enabling the "crop" to be placed on the market at a much earlier date than when the oysters be laid free on the general surface of the park, that in the heyday of the Arcachon oyster industry in the early nineties, the parkers carried case culture much further than is done now. In those days every parker had large numbers of cases in order to prolong the term of sojourn in these sanctuaries. About 1896 the number of cases in use in the basin was estimated

at fully 300,000, having a value of 3,000,000 francs. With reduced profits the parker of to-day cannot afford the great expense involved in the purchase and upkeep of a large number of cases ; he finds that he must economise on this item and to-day there are not more than 70,000 cases in use. At present then the minimum of cases are employed, just sufficient to accommodate, in crowded mass, the young oysters during the critical period of three to four months following their detachment from the collectors. Growth cannot be so rapid as it would be with plenty of cases available, but in practice the parker finds that the extra rapidity of growth given by prolonged case culture is not commensurate with the higher expenditure necessitated. Conditions of trade are such that he must now take risks which his predecessors did not and now that the risks have to be faced, they are not found so dangerous as was imagined.

As growth increases and space decreases the larger oysters are removed from the cases and spread free on the surface of the park. Formerly when prices were high, shallow ponds, called claires, for the reception and rearing of these oysters were excavated and enclosed on the higher portions of the concessions. Very heavy capital expenditure was incurred in levelling the ground, improving the surface by means of sand and gravel, in constructing solid embankments and in the provision of sluices for regulating the water level. A culturist of to-day would never dream of incurring such expense, indeed the solidly built claire, the true claire, belongs to that early period of oyster culture at Arcachon when conditions were so prosperous as to lead enthusiastic culturists into the rash pursuit of that expensive theoretical perfection and complexity of method which is so frequently opposed to the commercial success of a young industry.

The retaining wall of the classic claire, built solidly of clay and gravel retained by heavy planking supported by stout posts has been succeeded by a most ingenious and comparatively cheaply constructed substitute.

Around the area to be converted into a claire a shallow trench 6 to 8 inches wide is dug. Into this are packed quantities of short sticks (*brandes*), 18 inches long, disposed vertically in such manner that the greater portion of their length projects from the ground level to form a low and broad border about one foot in height and some 5 to 7 inches wide. The soil is packed in tightly on either side of this palisade border and when the interstices are filled up with clay a low bund has been formed capable of holding up a depth of 8 to 10 inches of water when the tide recedes, so long as the walls remain in good order. The construction of these latter-day claires whose bunds remind one of the closely trimmed boxwood borders of old English gardens entails little further expense than the cost of levelling the surface and of spreading a thin layer of fine sand and gravel when considered necessary as a means to consolidate the surface if it be muddy. This form of claire is found quite satisfactory and in a land where pine forests are extensive no cheaper method could be devised. The tendency to-day is to dispense with walled claires of even the cheapest description. Partly this is due to experience showing that in the mild and favourable conditions prevailing at Arcachon there is no very great advantage, save in particular localities, of troubling to keep the oysters continually covered with water, and partly, I am strongly inclined to believe, because a continuance of many years cultivation has very greatly improved the natural surface of the parks. Of recent years culture at Arcachon tends strongly towards simplification of methods; the number of rearing cases are reduced to a minimum and the great majority of parkers content themselves with scattering the young oysters over the smoothest and most protected section of their ground, there to develop without other protection than is afforded by a tall palisade of stakes primarily intended to exclude predatory fishes.

Whenever the tides serve, the oysters thus scattered over the surface of the park receive attention. Sea-weeds

are cleaned away, while starfishes and other vermin of the parks are destroyed. The oysters are raked over as frequently as possible to keep them well on the surface and whenever they are drifted into heaps or against the palisade, they are rescattered carefully.

A Government regulation forbids the export from Arcachon basin of oysters below 5 centimetres (2 inches) in greatest length, a size locally known as "*deux ans*" or 2 year-olds, this being the approximate age when this dimension is reached although on favourably situated parks where growth be exceptionally rapid it may be attained at 18 months of age. The rule was made to prevent the basin being depleted of breeding oysters, there being no natural reserve available to supply spat. As a consequence the Arcachon parkers specialize very largely in the production of these two year-olds for which there is a large demand from the oyster fattening farms of Marennes, La Tremblade and Ile d'Olèron ; Spain is also a large buyer. The bulk of the despatches from the basin of oysters from two to three years old a few years ago was enormous, averaging from 1898 to 1903 almost 300 millions per annum. For some three or four years past this home trade has diminished greatly, barely reaching a total of 100 millions for the years 1906 and 1907, whereas in the same years the export abroad chiefly of larger and older oysters soared suddenly from 20 millions in 1905 to 155 millions in 1906 and 157 millions in 1907. In this connection it may be noted that table consumption in France of Arcachon oysters (see table at the end of this section) has increased enormously since 1903 and accounted for 147 millions in 1907 as against a paltry annual average of $1\frac{1}{2}$ million for the series of years 1900-1903. Oysters required for consumption run from 4 to 5 years old at Arcachon. From this we infer that coincident with simplification of methods an increasing quantity of oysters of edible size are being produced, the culture and sale of 2 year-olds concurrently diminishing. The change is accounted for in part by the decrease in

demand from the fattening centres where the culturists are giving attention to spat collection on their own account and to the culture of the cheap and popular Portuguese species. Another factor is the desire of the Arcachon producer to counterbalance the lower prices offered in recent years for half-grown oysters by putting on the market full-grown stock for which a higher price is paid ; he is willing to put in more labour and wait longer for his market if thereby he may obtain a higher return. The change also shows the favourable effect of low prices upon the annual consumption. Till a few years ago oysters were a luxury for the well-to-do ; now-a-days, thanks to competition, the curtailment of cultural expenses and the advent of the culture of the Portuguese oyster—cheaply grown, tasty and large of body—oysters of fair quality are now within the reach of the masses and Arcachon benefits accordingly, for its oysters have not the reputation of those of Marennes and being unable to fetch a high price are more and more in request by those of limited purse.

Besides the regulation forbidding the exportation * of oysters under 5 cms. in size, another is in force restricting the export of all oysters of legal size to the period between 1st September and 15th May. According to the number to be sold or the condition of the sale the oysters are classed either on the park itself or after being brought ashore. Experience enables the skilled parker to estimate the grade of his different oysters very accurately by eye. In collecting them for delivery to the purchasers, his employés rake the oysters together into heaps, count them roughly by hundreds into net-bags (*pannetières*), and load them into the pinasses. On delivery, the buyer or his agent selects a bag here and there, counts, weighs and otherwise verifies the conformity of the delivery to the samples on which the sale was effected. The custom is to count 1,010 oyster to

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* Exportation here means sale outside the limits of the basin ; it is not used in the more usual sense meaning despatch to foreign countries,

each nominal thousand, a bonus to the purchaser of one per cent.

Formerly the classification was by centimetre dimension, the oysters running in grades of $\frac{1}{2}$ and $\frac{1}{4}$ centimetre difference, $5-5\frac{1}{4}$, $5-5\frac{1}{2}$, $5\frac{1}{2}-6$ and so on. This classification had several drawbacks and opened the door to imposition and endless bickering and grumbling, till in 1904 the system of combining measurement and weight in the grading was introduced. By this system the classification ran as follows :—

Sizes.	Weight per 1,000.
5-5½ cms.	Up to 26 kilos.
5-5½ „	27 kilos and above.
5½ cms. and over	From 35-39 kilos.
Do.	„ 40-44 „
Do.	„ 45-49 „
6 cms. and over	„ 50-54 „
Do.	„ 55-59 „
Do.	„ 60-64 „
Do.	„ 65-69 „

Weight per thousand is now the accepted standard of the trade ; it has proved satisfactory and is free from many of the drawbacks inherent to sale based on measurement.

Table showing the changes taking place in the disposal of the annual output of indigenous oysters (O. edulis) *from Arcachon basin.*

Year.	Total output.	Disposal.		
		Sold to other French rearing establishments.	Sent abroad.	Table consumption.
1898 ...	318,272,500	307,872,500	9,400,000	1,000,000
1899 ...	297,484,000	292,084,000	4,400,000	1,000,000
1900 ...	318,890,000	309,030,000	8,360,000	1,500,000
1901 ...	291,255,000	280,255,000	9,500,000	1,500,000
1902 ...	308,544,000	302,703,000	3,900,000	1,500,000
1903 ...	299,550,000	290,250,000	7,800,000	1,500,000
1904 ...	75,684,000	40,684,600	20,000,000	15,000,000
1905 ...	420,000,000	200,000,000	20,000,000	200,000,000
1906 ...	261,344,000	52,000,000	154,938,000	53,806,000
1907 ...	352,557,000	48,700,000	146,980,000	147,377,000

(*f*) *Enemies and Diseases.*

Man himself is and has been the greatest devastator of oyster beds ; at the present time his reckless and short-sighted fishing has actually destroyed practically all the great natural beds on the French and English coasts which about the middle of last century were being dredged over by hundreds of oyster smacks in the season. A few odd remnants alone are left, the most important, that of Cancale, being kept in existence solely by stringent State regulations and the limitation of the fishery to one or two days in each season.

In regard to oysters under cultivation the enemies are those normal to shallow water natural beds, in some cases aggravated and in others diminished, by the conditions of culture. Boring molluscs, starfishes, crabs, predatory fishes, and tunnelling worms and sponges comprise the list of active enemies ; mussels, sponges, ascidians and other attached or crusting invertebrate growths together with sea-weeds of various species form a second category, that of passive enemies—which by excessive competition for the microscopic food in the water or by stifling over-growth may entail as wide-spread injury at times as the inroad of the battalions of active foes. Apart too from the actual injury caused from time to time the precautionary measures rendered necessary to safeguard the parks and minimize the risks arising from these dangers involve heavy and constantly recurring expenditure, special measures of defence having to be taken against each of the principal classes of depredators and parasites.

Boring molluscs.—The species responsible for almost all the loss from this class of enemies is a small species of *Murex*, a genus of gastropod molluscs noted for their carnivorous habits. Their mouth parts include a long ribbon carrying hundreds of narrow rows of very tough and sharp horny teeth ; by means of these teeth the little mollusc—it is scarcely an inch in length—can bore through the thickest and hardest shells, the wear of the teeth at the front end of the ribbon being made good by

the continuous development and growth of new rows at the hinder extremity.

As is natural the thin valves of young oysters are much more readily pierced than the thick, dense, and harder shells of adult individuals ; indeed at Arcachon it has been proved that whereas a Murex is able to bore a hole through a valve of a month-old oyster within half an hour, it takes eight hours for the same sized enemy to pierce the shell of one three years old. These little gastropod vermin show a very great preference for brood oysters and have been responsible for the destruction of great quantities in some years. So numerous were they at one time at Arcachon and so extensive the losses they caused that both the Dutch oyster-rearers and the Whitstable oyster companies which till then had been in the habit of taking some of their supplies from Arcachon, alarmed lest they should import the scourge, decided in 1883 to buy no further quantities of young oysters from Arcachon ; great difficulty was experienced in persuading these buyers to remove the embargo.

As an instance of the dimensions assumed by this plague in former years, we may note that one season men of the guard boat then stationed to protect the Imperial oyster parks collected in a single tide from one park having an area of 4 hectares, nearly 15,000 *Cormaillots*, as this little Murex is named locally ; the next day almost as many were gathered from the same ground. We may be certain that if 30,000 were taken in two days on these 4 hectares, the original Murex population of this area must have approached 100,000, if indeed it did not exceed this number. It requires no abstruse calculation to realize how rapidly a bed of brood oysters will diminish before the inroads of such a host. Fortunately the war which the parkers have waged incessantly on this most dangerous enemy have been eminently successful ; its numbers have so diminished that the parkers no longer dread it, confident that the exercise of ordinary care in destroying adults and egg cases whenever seen, will prevent the reappearance of the scourge in dangerous numbers.

Starfishes are not dreaded at Arcachon to the extent they are in England or the United States. Their numbers and the amount of harm they do are inconsiderable in most years and when they do appear it is difficult to say whether the harm they cause is not more than counterbalanced by the good they effect by destroying mussels for which they show a decided preference, not because they prefer the flavour of the mussel to that of the oyster, but probably because they find it easier to exhaust the former and drag apart its valves.

The comparative immunity of the Arcachon parks from the attacks of starfishes appears to be due to the fact that the beds are not permanently under water. Starfishes do not stand exposure well and are seldom found between tide-marks ; besides, the almost daily attention the parks receive enables the parker to destroy at once any which do find their way into the basin, starfish being conspicuous objects when stranded.

Shell-tunnelling worms (*Leucodore*) and sponges (*Clione*) are met with at Arcachon, but scarcely deserve mention, so inconsiderable is the harm they do owing partly to the high cultivation and cleanliness prevailing, and to the fact that the bulk of the oysters are vended at an early age. No very old oysters are ever kept on hand in the basin and as no accumulation of calcareous rubbish is tolerated in the parks, neither of these foes, which elsewhere sometimes occasion considerable loss, finds favourable life-conditions to multiply at Arcachon. Enemies of this class are as weeds on agricultural land, of no account so long as the fields receive careful attention at the proper seasons but a bane and source of loss whenever vigilance is relaxed.

Crabs and fishes at the present time give the greatest trouble to the parkers, occasioning heavy loss if adequate protective measures be not continually kept up. The worst offender amongst the crabs is the common green shore-crab, *Carcinus mœnas.* They occur in great numbers and defy all attempts at extirpation. To mature oysters they can do little or no mischief, a two year-old

oyster being quite a match for any green crab. With delicate-shelled brood oysters for months after détroquage and also while these young are still attached to the collectors, the case is different; the crab has no difficulty in breaking away the lip of the shell and picking out the delicate morsel within.

Of fishes quite a number occasionally feed upon brood-oysters, but it is in regard to the maturing oysters that the parkers fear fishes more particularly. Indeed just as crabs may be considered the special enemies of young oysters, so fishes hold this position towards the adult generations. Large mollusc-eating relatives of the rays are the special dread of the parker and against these his most elaborate and expensive protective devices are directed. The worst offenders are the tére (*Trygon pastinaca*) and the epervier (*Myliobatis aquila*), whose jaws are armed with a mosaic of strong milling teeth capable of crushing with ease even thick-shelled adult oysters. Of the two species of oyster cultivated at Arcachon the *tère* prefers the heavy shelled Portuguese for though the shell be thicker than in the native species it is softer and the contents are larger and presumably more satisfying to the depredator. It is interesting to note that the inroads of large shoals of a related species of ray (*Rhinoptera javanica*) are the frequent cause of the total disappearance of extensive beds of pearl-oysters off the coasts of India and Ceylon where instances are known of millions of maturing oysters being cleared away during the interval between examination in November of one year and February of the next. Fishes undoubtedly are the most dangerous enemies with which the Arcachon cultivators of edible oysters and the owners of the pearl banks in the East have to battle.

Of passive enemies the list comprises practically all sedentary marine organisms that flourish in shallow waters and between tide-marks. Constant attention to ensuring the cleanliness of the parks prevents the majority doing much harm; it is the careless parker—a man seldom met with at Arcachon—who suffers severely

from these silent unobtrusive enemies. As may be readily understood the chief danger from this source arises during the period the collector tiles are stacked in the ruches. At that time the water is full of the embryos and larvæ of a host of creatures all as keen to find clean firm foothold as are the swimming spat of the oyster. Every one that attaches to a collector reduces the space available for oyster settlement and as these intruders increase in size and appetite they compete with the young oysters for the current-brought food—a competition which if not checked results in stunting and virtual arrest of growth. Mussels and sea-squirts (ascidians) are the most troublesome of these greedy and unwelcome creatures but whereas the latter settle chiefly on the surface of the tiles, the former cluster by preference on the wooden frames of the ruches and on the exposed edges and ends of the tiles, positions which enable them to intercept the bulk of the food matter before it flows through the stack of tiles. Always do mussels select the positions which give them the vantage of being able to filter out and seize the best of the food brought by the tides and currents. Apart from the collectors their favourite settlement is upon the fences that surround the parks and the faggot bunds of the claires. A wall of greedy mouths encircles every park, impoverishing the waters and robbing the oysters even of their fair share of the common food supply. In some years the abundance of mussels has entailed most serious losses upon the parkers, for besides causing stunting of growth an enormous abundance may so prejudicially affect the spat-fall as to produce actual scarcity. It happens that the mussels spawn rather earlier than the oysters so while the latter are yet in the swimming stage the mussels have settled down and are busy filtering out the little particles of food essential to the well-being of the oysters.

The lug-worm (*Arenicola*) gives trouble to the parker in quite a different way. This worm has the habit of burrowing in muddy sand, feeding on the decaying organic

matter contained therein after the manner of the earth-worm on land. Darwin has shown what an enormous amount of soil is passed through the bodies of earthworms during this feeding and how the lower layers of the soil are gradually transported to the surface by this agency. I have elsewhere* described how the same work is being carried on by the lug-worm on the littoral and on the sea-bottom wherever muddy sands occur. Indeed in Europe the vermicelli-like castings of this worm are familiar to every visitor to the sea shore. In many cases lug-worms perform a useful function in aërating and cleaning the foul under layers of sandy beaches especially wherever quantities of sea-weeds are cast ashore and covered with sand; in Arcachon oyster parks they cause trouble by bringing mud to the surface from below the well-consolidated superficial layer formed by the parker with trouble and expense. If a large number of these worms are at work in a park the amount of mud brought up and spread over the surface is very appreciable and so slowly and quietly does the damage progress that many parkers actually are not aware of the importance of this source of the mudding of their ground.

The last group of passive enemies is that of the sea-weeds. Various species are incriminated, acting in differing manner. Some envelop the oyster in stifling swathes, others buoy it up and enable the waves to carry it away; some by the luxuriance of their growth lessen the rapidity of currents over the parks and cause an increase in the amount of mud deposited; another class cause loss to oyster culturists by the decomposition of their fronds when stormy weather uproots them in mass to fling in heaps upon the oyster-strewn surface of the parks. The greatest harm is wrought by the operation of the two first named factors. The sea-lettuce (*Ulva lactuca*), and the tufted red algæ termed "bouquet" at Arcachon (*Chondria tenuissima* and *Hypnea musciformis*) are the worst offenders among the weeds whose

* "Journal of Mar. Zoology and Microscopy," p. 27, Vol. I.

growth upon the valves of oysters produces a buoyancy entailing much loss to parkers at Arcachon. The specific gravity of these algæ is scarcely more than that of sea water and so when their tufts fall flaccid upon themselves on the recession of the tide, many of the gas bubbles disengaged by their cells during the process of assimilation are imprisoned among the filaments; on the return of the tide the accumulation of these bubbes is often sufficient to render the tuft so buoyant that the oysters whereon they grow are floated up and carried towards the boundary of the park. There the palisade of pine branches may arrest their further course, but wherever a gap occurs they are carried through either to float into an adjacent park or to be lost in the no-man's land of the channels. It is noteworthy that "bouquet" is a trouble of recent origin. In 1878 it was not known or at least was so unimportant as not to be noted as an oyster culture danger by MM. de Montaugé, practical culturists, who published in that year an exhaustive summary of the then known oyster enemies and maladies of the Arcachon basin. Both the algæ included under the term "bouquet" are species properly belonging to the Mediterranean and subtropical Atlantic and while the range of *Chondria tenuissima* extends to England, *Hypnea musciformis* is not known to thrive north of Arcachon. Another alga, the "balloon weed", *Colpomenia sinuosa*, is another very active species in floating away oysters, but so far it has not established itself in the Arcachon district.

Considerable loss from this cause can be avoided only by constantly cleaning the oyster shells, rubbing them against one another, a process which necessitates the expenditure of much labour. High level parks suffer least as a hot sun or heavy showers of rain occurring at low water during spring tides kill off the bulk of the harmful tufts of "bouquet". Sauvageau* suggests the utilization of the herbivorous periwinkle, *Littorina*

* "*A propos du Colpomenia sinuosa.*" [Travaux des laboratoires du Station biologique d'Arcachon, 1906.]

littorea, to combat the growth of "bouquet", quoting the success attending the employment of this measure in the claires of Sable-d'Olonne. *Chondria* and *Hypnea* appear in summer and disappear in winter.

The green filaments of *Enteromorpha* and *Cladophora*, constituting the "*limon vert*" or green mud of the Arcachonnais parkers, are the important smothering algæ of this district, enwrapping the oysters in a dense green blanket under the action of brisk currents or rough weather.

The common brown wrack *Fucus vesiculosus* grows luxuriantly on the boundary palisades and on the pointed stakes employed against predatory fishes and contributes appreciably to the deposit upon the parks of mud and sand from suspension in the water; on the other hand, the damp fronds of this wrack form an excellent material in which to pack oysters for despatch by rail.

The tangle of delicate filaments characterising the growth habit of the green conferva *Vaucheria thuretii*, is a much more serious danger. This "cat's hair" of the parkers penetrates the muddy bottom of the claires to some depth with a net-work of threads retaining and fixing sediment as it settles to the bottom. In this way it tends to raise the level of the mud in the parks and so cause deterioration of the surface. This obliges the parkers to incur considerable and frequently recurring expenditure upon the removal of the mud and sand thus accumulated.

Sea-grass (*Zostera*) and the wrack above mentioned (*F. vesiculosus*) are occasionally uprooted in great quantities by storms and thrown within the parks; unless removed quickly their decomposition is said to cause serious losses.

Diseases.—In addition to the many visible enemies from which the parker has to guard his beds of oysters, other malignant influences, more subtle, less easily recognized, and more difficult to combat, occasionally appear

and produce diseases of serious gravity sometimes epidemic in character. The more dangerous of the ailments which afflict oysters under cultivation at Arcachon are those known locally as *doussain* or *douçain*, *typhus*, *chambrage*, *boudeuse* or *rachitique* and disease of the adductor muscle.

Under the name of douçain, Arcachon parkers refer to the chief ailment caused by an excessive reduction in the salinity of the water bathing the oyster beds, consequent upon floods resulting from prolonged rains over the catchment areas of the streams emptying into the Arcachon basin, whence douçain, the disease caused by *eau douce*. Among marine animals the oyster is one of the most tolerant towards variations of salinity, so long as they are not excessive and long continued. If they be, the oysters gradually sicken and if the adverse conditions be further continued widespread death ensues. The first sign of a reduced salinity is seen in the gradual enlargement and "plumping" of the body, the liver suffering great enlargement (hepatitis). This condition of hypertrophy of the tissues in general and of the liver and other glandular organs in particular is due to the same cause and is indeed identical with the artificial and rapid "fattening" to which ignorant or unscrupulous dealers often subject consignments of oysters to be consumed forthwith, a process consisting of laying the oysters in ponds or in tubs containing fresh water. The "fattening" in merely the osmotic exudation of dense fluid from the cells and vessels of the body and replacement by the in-taking of a *larger* volume of the less dense fluid without. More water enters than leaves the tissues in obedience to a well-known physical law, with the result that distension and discomfort first ensue, followed by a disorganization of secretory functions and the eventual break-down and death of the entire organism. Parks situated towards the eastern and northern (interior) extremities of the basin are most liable to suffer from this disease, being

more open to the influence of flood water than those at the seaward angle of the basin. No remedy other than the removal of the cause is practicable, so when a parker finds his losses are frequent and excessive the only alternative is to abandon his concession and take another in a more favourably situated location.

The converse of the condition which eventuates in douçain is that where the water becomes excessively saline and of a density abnormally above that of ordinary sea water. As the other extreme produces disease so also does this. At Arcachon it is occasionally experienced on the parks most distant from the sea in seasons of exceptional drought. Fortunately this condition is of very rare occurrence and quite exceptional. The tissues of oysters subjected to a sojourn in extremely saline waters shrink greatly and undergo the same desiccating process that fish do in course of salting or brining. If eaten in this state the oyster is tough and indigestible.

Typhus and *chambrage* are diseases due to the presence of an undue amount of fine mud in suspension in the water. Parks with soft muddy bottom are liable to this as the daily operations in the park disturb the surface and when the tide flows over it the light mud rises and passes to the gills of the oysters, so interfering with nutrition. Typhus is in fact a starvation disease induced by a great preponderance of non-digestible inorganic particles over those of food value in the material ingested. Chambrage is the name given to an ailment which affects sections of the shell-secreting surface of the mantle—an inflammation apparently. Its visible result is the formation within the shell substance of a cavity filled with malodorous putrescent fluid.

Much more serious is disease of the adductor muscle, known erroneously at Arcachon as *maladie du pied.* In some years, notably 1877–78, it has assumed an epidemic form causing losses of considerable moment to the parkers. It is a fungoid disease affecting the muscle fibres of the great cylindrical adductor muscle which lies

transversely in the body, its ends attached respectively to the right and left valves. By the contraction and relaxation of this muscle the shell is alternately closed and opened. When disease attacks it, its fibres waste, the adhesion of the ends of the muscle to the inner face of the valves is impaired and the insertion surface becomes rough, irregular, and often quite tubercular. Concurrently the muscle gradually loses its power to sustain prolonged contraction, the shell gapes and in this condition the oyster becomes an easy prey to predaceous foes. If it does not perish thus, life gradually ebbs away, the oyster dying from debility, the inability of the organs to carry on their respective functions.

The last disease of sufficient importance to warrant notice is *boudeuse*, the virtual cessation of growth affecting oysters *en masse*. It is a condition directly induced by overcrowding in localities where the food supply is not sufficiently superabundant as to sustain the rapidly increasing demands made upon it by millions of young oysters hastening to maturity. While the oysters are quite small, their collective appetites may be adequately satisfied but while the amount of food available may be sufficient for a given quantity of one-year-olds, it may be wholly inadequate for the same number at double that age. Usually this disease does become apparent among crowded oysters about the age of two years. The only remedy is to reduce the numbers very greatly, but when the ailment has affected the oysters for any considerable period its stunting effect becomes established and even when such oysters are transferred to parks where the food supply is rich, they never develop into a really satisfactory condition ; they retain their stunted appearance more or less for the remainder of their existence.

From this list of enemies and diseases whereby the stock may be depleted one might infer that oyster culture is surrounded by very serious risks. In practice the careful parker has seldom to think seriously of more than two or three of these inimical influences against

which he takes well recognized precautions; danger from the others, to the culturist who gives adequate attention to his farm, is automatically eliminated, although they may be rampant and spell ruin to him who slackens in assiduity.

(*g*) *Protective devices against enemies.*

Permanent protective devices are confined almost entirely to secure comparative immunity from the depredations of fishes and crabs. Against the former, two systems of defence are employed either separately or, more usually, in combination. The principal and universally adopted is that of protecting the park with a tall and very closely planted hedge or palisade of pine branches. These tall branches are implanted in the soil at intervals apart of 1½ to 4 inches and vary in height from 8 to 12 feet (Pl. IV., fig. 15). No park is complete without such a palisade either entirely surrounding it in the case of one situated on a flat environed by water at low tide or only on the seaward margin if it be situated on the littoral of the mainland. The tall branches, *pignots*, should be long enough to reach the surface at high tide, so that predatory oyster-eating fishes may either be scared away or prevented entry if they make the attempt. In point of fact many do find admission usually through gaps in the fence where the stakes have been broken or carried away during rough weather. Those that do so enter as a rule pay the penalty with their lives, the parkers finding them stranded or imprisoned on the recession of the tide. Several rays were so seen on the day I inspected the parks near Cape Ferret and I was informed that the parkers often leave the dead bodies among the oysters in the belief that this scares other fish away.

The second system of defence against fishes, that of studding the ground with pointed stakes, is usually practised in conjunction with the first but either may be used separately and singly. The stakes used are sticks

pointed at each end. They are cut of sufficient length for the upper portion to project 8 or 9 inches when the lower end is embedded to a depth 4 to 5 inches in the ground (Pl. V., fig. 16). These pointed stakes or *piquets* are very largely employed wherever the Portuguese oyster is under cultivation, the voracious *tère* being most partial to this species whose shell though thicker is softer and without the very hard porcelain-like nacreous lining that the indigenous oyster, *O. edulis*, possesses. The piquets are very closely set, not more than 10 to 12 inches apart, and although obtained at a very cheap rate (Rs. 1–8–0 to Rs. 1–14–0 per 100) from the pine forests surrounding the basin, the great numbers required to afford adequate protection form a heavy item in the parkers' annual budget. Against the expenses of fencing and picquetage is to be set the fact that they insure all but entire immunity from one of the chief sources of loss to which the culturist is exposed. It may also be noted that fencing has the additional advantages of providing boundary marks and serving as obstructions to the carrying away of oysters from the parks by storm action and the floating power of certain sea-weeds. In some cases where regular claire bunds are not employed, this surrounding outer fence is constructed in composite fashion combining in itself the functions of fencing and claire bund. In such case instead of being a simple and single row of closely set branches, it is double rowed at the base, a space of 8 to 12 inches separating an inner row of tall poles from an outer line of much shorter stakes. This space to a height of 6 to 8 inches is filled in with tightly packed brushwood, either the feathery ends of pine branches or, better still, bundles of tall-growing heather. In emplanting the outer row of short stakes which project a foot or 18 inches above the surface care is taken to place them at an angle inclining slightly inwards in order to keep the brushwood firmly in position.

It is necessary to note here that adjoining parks may not have a common or party boundary fence; the

conditions under which the parks are held stipulate for the maintenance of a passage way one metre wide between adjoining concessions.

Crabs are the most active and persistent enemies of the oyster culturist. They are combated in two ways, either by measures intended to prevent their entrance into the enclosures where young oysters are spread, or by an active campaign against them by traps and other means of capture. The approved method by which exclusion is very successfully attained is an ingenious system of fencing called *blindage* invented by Messrs. de Montaugé, prominent oyster culturists at Arcachon, and practised very extensively in the parks along the western shores of the basin.

The park to be safeguarded, which is always that containing the youngest oysters belonging to the parti-

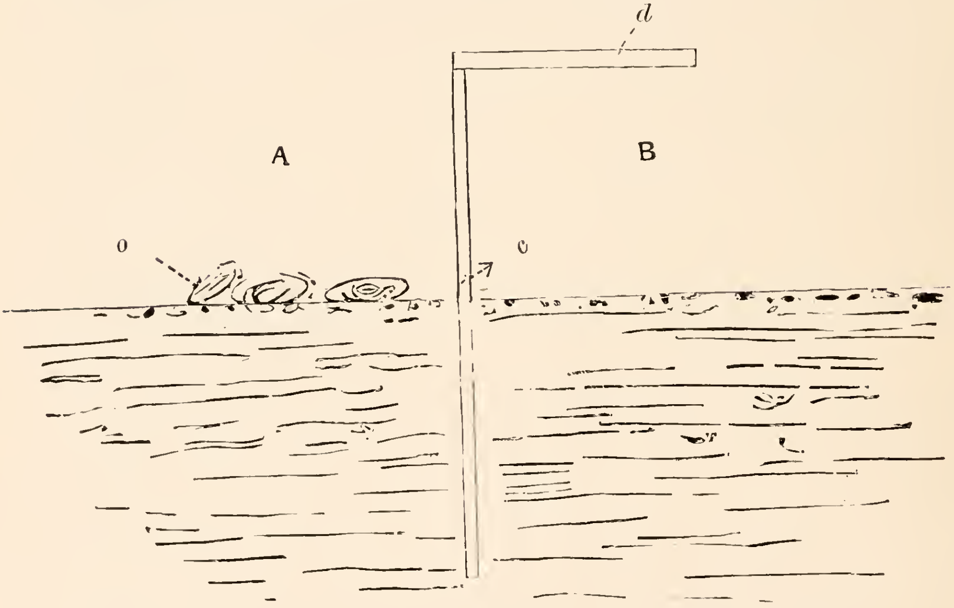

Fig. 6.—Section to show the Arrangement of Blindage Planking employed to protect young Oysters against Crabs.

A. Inside of Enclosure where Oysters (*o*) are placed ;
B. Exterior of Enclosure.
c. Vertical Plank of Enclosure ;
d. Horizontal plank nailed to edge of *c.*

cular proprietor, is surrounded by a low barrier made of planking or preferably of wire netting set in a wooden frame, rising not more than 4 to $4\frac{1}{2}$ inches above the ground level (Pl. V., fig. 17 and Pl. VI., fig. 19). To the upper edge of this and at right angles to it a narrow plank of thin wood $2\frac{1}{2}$ to 4 inches wide, is nailed by one margin in such a way that the remainder projects outwards and away from the park.

To secure the vertical barrier from displacement as well as to prevent crabs tunnelling beneath, it is necessary to imbed the lower edge several inches in the soil. This device is very practical and effective (see fig. 6). Crabs find it impossible to climb over, falling back whenever they attempt to pass the horizontal outwardly projecting plank.

The cost of this protective device in wire netting runs about 3 annas per yard ; an all-wood barrier costs less but requires more frequent repair.

The traps used to supplement blindage by capturing the crabs which tend to congregate along the outer margin of the protective barriers are of two kinds. One

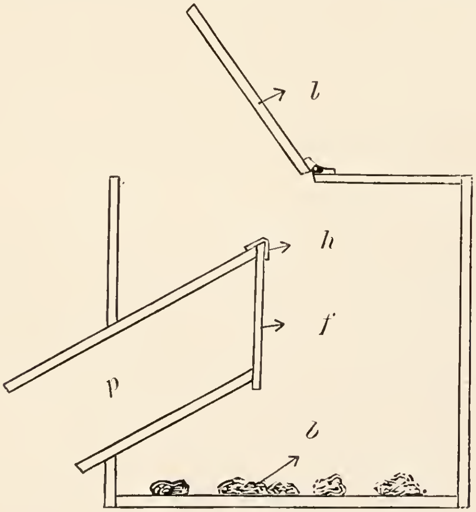

Fig. 7.—Section of Box-trap for Crabs.

p. Sloping Passage into Trap ;
f. Hinged Door or Flap at inner End of Passage ;
h. Hinge. *l*. Service lid ; *b*. Bait.

is a wooden box-trap, the other a wire-net cage-like cylinder. The former is a roughly made rectangular case provided with a trapped tunnel-shaped opening towards the lower edge of one side. Half of the cover is hinged to form a lid to give ready access to the interior. Bait, preferably fragments of cuttle fish, is placed inside the box and the lid secured. Crabs attracted by the tempting odour emanating from the box, crawl up the tunnel in the side, push open a light flap or door hinged at the inner end of the passage and drop into the interior.

When they try to get out they find their exit barred by the trap door (see fig. 7). This trap is highly esteemed for its high efficiency (Pl. VI., fig. 18).

The cage trap is almost equally good; it consists of a cylinder of wire netting with a sleeve entrance in the same material at one end. An iron ring around each end serves as a supporting frame (Pl. VI, fig. 19). A heavy weight secures the trap in position; it is baited in the usual manner. With the diminished employment of ambulance cases during recent years increasing attention has been given to the trapping of crabs; indeed we may say that the adoption of the system of blindage in conjunction with an energetic campaign against crabs has been the means of enabling parkers to dispense very largely with ambulance cases, and thereby effect a great economy.

All other enemies save perhaps mussels are of inferior importance and require no special protective apparatus. The majority, as we have already seen, are sufficiently held in check so long as the parks are properly cared for and every effort made to ensure cleanliness and good order.

Mussels when very aggressive may be combated by the introduction of starfishes which are particularly fond of mussels. There is however always a danger that they may devote their attention to the brood-oysters. The best remedy is hand picking and the diligent cleaning of all sticks and stakes to which the mussels adhere, just as

Fig. 8.—Hopper barge used for the removal of sand, Cape Ferret Oyster Parks.

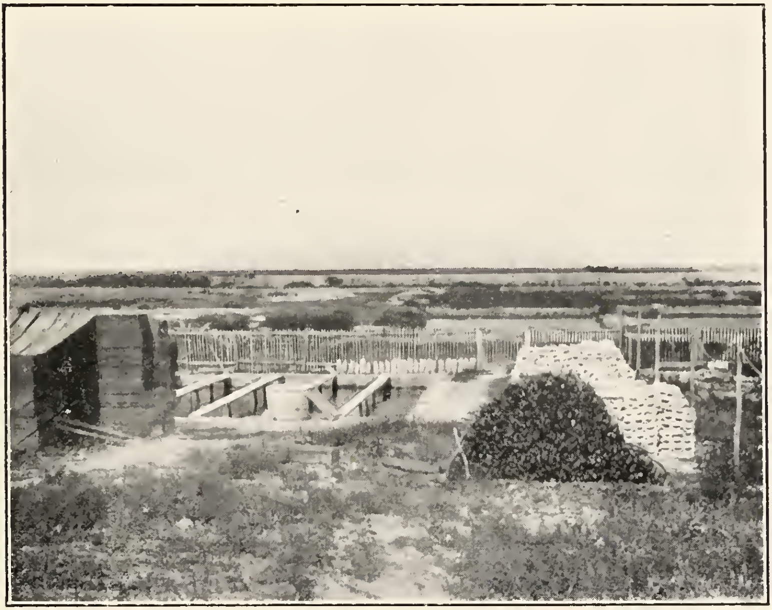

Fig. 9.—An Oyster Parker's yard and store tank.

[*Photo. J. Hornell.*]

FIG. 10.—LIMING TILES, LA TESTE, ARCACHON.

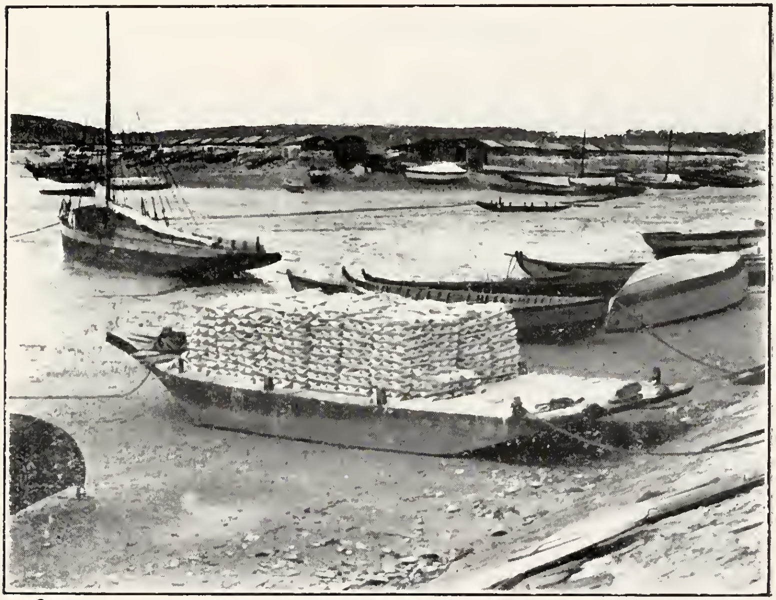

FIG. 11.—A BARGE LADEN WITH LIMED TILES, LA TESTE, ARCACHON.

[Photo. J. Hornell.]

FIG. 12.—FILLING RÛCHES WITH TILE COLLECTORS, ARCACHON.

FIG. 13.—NAILING ON THE LAST BATTENS. A RÛCHE FILLED WITH TILES AND COVERED WITH A LAYER OF BRUSHWOOD.

[*Photo. J. Hornell.*]

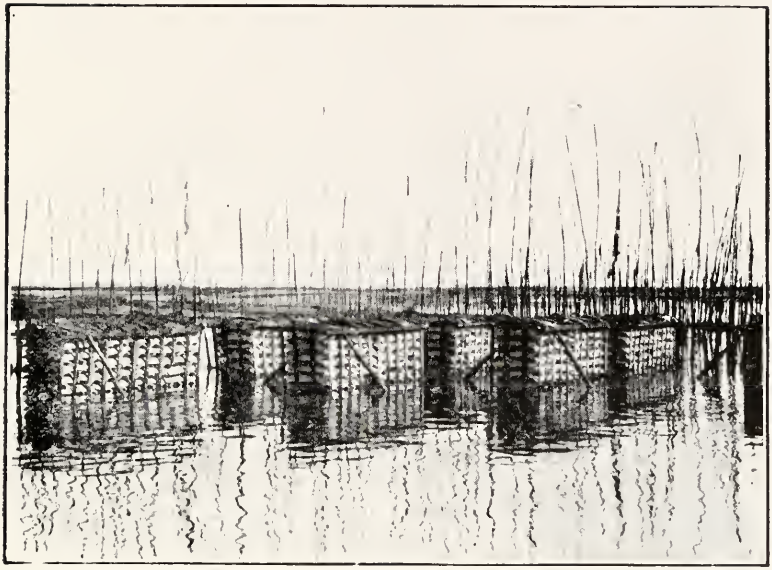

Fig. 14.—Arcachon. A series of rûche cases in position along the margin of a channel.

Fig. 15.—An Arcachon oyster park, showing two "ambulances," palisades and claires. The foreground is covered with one-year old oysters.

[*Photo. J. Hornell.*]

FIG. 16.—AN OYSTER PARK NEAR CAPE FERRET, SHOWING HOW THE GROUND IS STAKED AGAINST PREDATORY FISHES.

FIG. 17.—YOUNG OYSTERS PROTECTED BY "BLINDAGE" AGAINST THE ATTACKS OF CRABS. CAPE FERRET, ARCACHON.

[*Photo. J. Hornell.*]

FIG. 18.—BOX-TRAP USED TO CAPTURE CRABS ON ARCACHON OYSTER PARKS.

FIG. 19.—WIRE NET CRAB-TRAP USED AT CAPE FERRET, ARCACHON, OUTSIDE OF GROUND SPREAD WITH YOUNG OYSTERS AND SURROUNDED BY "BLINDAGE" PLANKING WHEREON M. L. MICHELET IS SEATED.

[*Photo. J. Hornell.*]

hand-picking is the most efficient check upon the increase of Murex, ascidians, sea-weeds and other minor foes.

Birds occasionally seek to feed upon the brood-oysters; to frighten them away scare-crows are sometimes put up in the parks just as a farmer does on land.

(*h*) *Expenses and Profits.*

Capital outlay and the produce of an oyster park are so dependent upon a number of extremely variable conditions and circumstances that it is most difficult to give even an approximate estimate of average profits made by the oyster culturists of Arcachon. No two parks are alike in situation, area and results. One may have had originally a well consolidated surface requiring little expenditure to fit it as culture ground, another had a soft, muddy surface necessitating a large outlay before it was fit to be used as an oyster park. Some parks are specially open to one or other of the dangers besetting this industry; those at the landward side of the basin are liable to injury through fresh-water floods, those at the seaward end to damage from gales. One culturist may work a large area and so be able to conduct his operations more economically than a neighbour having but a small plot.

Then the situation of one park may be extremely favourable for spat collection and its lessee then makes handsome profits by the sale of brood oysters while another is valueless for spat collection but may be suitable for rearing and fattening; the expenses and profits of these parks necessarily differ greatly, principally owing to the varying amount of labour involved in these several branches of culture. Such lands are largely in the hands of the descendants of the original concessionaires and exhibit by the high prices realized when any do change hands, how high is their reputation as profit-earning parks. After these parks of primary value come a large number of parks having very secondary value where returns vary from moderate to poor—where in many cases the laborious efforts of the whole

of the parker's family may give results that barely suffice for the scantiest of daily needs.

Capital Expenditure.—Oyster culture at Arcachon now counts so many years of development and expansion behind it that no good virgin ground is now available for new enterprise ; all suitable areas have long been taken up and any one who wishes either to take up the business of oyster culture or to extend his present holding can do so only by buying up the interest of some other culturist.

For the better class of parks the transfer price varies between wide limits ; between 6,000 to 15,000 francs per hectare (Rs. 3,600 to Rs. 9,000 for slightly less than 2½ acres) for fairly good average situations ; parks of special excellence, particularly those where the growth of oysters is specially rapid, are valued very much higher, from 20,000 to 40,000 francs per hectare (Rs. 12,000 to 24,000 per 2½ acres) being demanded by their lessees. Indeed even higher values than these are sometimes placed upon the best situated parks ; one prominent parker personally informed me that he had refused to sell at the rate of 40,000 francs per hectare and that he would not sell under 50,000 francs the hectare and even at this enormous price, *over Rs. 12,000 per acre*, he would be loth to part with any portion of his concession, so large are the profits he nets from it. Legally a concessionaire has no right to ask such large sums for the transfer of the ground he has rented from the State. The law requires that the transferee shall merely reimburse the holder for the actual cost of improvements effected ; it does not recognize the right of the holder to unearned increment, but this regulation through the concurrence of buyer and seller is regularly evaded.

On the transfer of a park in full working order and of average value, costing anything from Rs. 1,500 to Rs. 4,500 per acre, the new owner should find the laying ground properly levelled, consolidated, and, when in the form of a claire, surrounded by a low faggot bund ; according to the situation of the park in the basin and the species of oyster being reared, a certain area should

be staked against the ravages of fish; a proper quota of ruches, tiles and ambulances should be present and the whole park protected by a palisade of pine branches along the boundaries where this is necessary.

The cost of levelling and consolidating virgin ground is so variable that it is impossible to give any figures; the items of expense consist of labour paid at the rate of Rs. 1–12–9 (3 francs) per day and gravel costing Rs. 2–6–5 per 6 cubic metres. Bunded claires are now little used, but even in their simplest and cheapest form when faggots or brushwood bundles are employed, the expenditure is considerable as the material alone costs about 10 pies per bundle or about Rs. 5 per 100. Usually some 30 ruches go to the acre; tarred and ready for use these cost Re. 1 each—Rs. 30 per acre. One hundred tiles are packed in each ruche, 3,000 in all. According to demand the price of these special tiles fluctuates between Rs. 27 and Rs. 30 per 1,000, so the complement of ruches and tiles per acre entails an initial expenditure of about Rs. 115 for material alone.

Rearing cases or ambulances are another source of heavy initial expenditure, so much so that culturists in these days of low prices for their products prefer to run considerable risks rather than spend large sums on this form of protection seeing that each case costs Rs. 7 and has but a restricted life even though the utmost care be taken to effect repairs annually. Eight to ten cases are however commonly apportioned to each acre as the proper complement and thus we see that this item alone entails an expenditure of Rs. 56 to Rs. 70 per acre every few years.

A still heavier expense is that of protecting the larger sized oysters in the park against predatory fishes and against crabs. The pointed sticks used for staking the ground against such enemies as *Trygon pastinaca* cost from Rs. 1–8–0 to Rs. 1–13–0 per 100, pine branches for the outside palisade Rs. 9 to Rs. 15 per 1,000 according to the length, and blindage against crabs, about 3 annas per yard.

The annual upkeep and working expenses of a park of one hectare or 2½ acres in extent is approximately as follows * :—

Upkeep of the park—	RS.	
Sand and gravel	24	
Stakes	6	
Fascines for repair of claire ...	18	
Planking	18	
Palisade repair	6	
		Rs. 72
Upkeep of apparatus—		
Repair of ruches	60	
Liming of 800 tiles	78	
Renewal of implements ...	30	
Upkeep of boat	15	
		„ 183
Labour—		
On the parks—		
2 men for 250 tides @ 3 fcs. each per tide = 1,500 fcs.	900	
3 women for 250 tides @ 2 fcs. each per tide = 1,500 fcs.	900	
Ashore—		
Détroquage	60	
		„ 1,860
Expenses connected with sale and despatch		„ 120
Rental		„ 32
Miscellaneous		„ 33
	Total Rs.	2,300

To this total must be added the interest upon the capital expenditure incurred, and the unforeseen expenses which generally become necessary from one cause or another, as for instance damage caused by stormy weather or the purchase of brood oysters to make good shortage of collection.

The expenditure given infers most economical working, the concessionaire and his family labouring themselves on the park. When family assistance is not

* These figures are adapted from those given by Boubés in his *L'ostreiculture à Arcachon*, 1909.

available and all the labour has to be hired expenditure is considerably increased and profits decrease correspondingly. Everything taken into account the working expenses of an ordinarily well cultivated park range anywhere from Rs. 1,100 to Rs. 1,700 per acre; under what may be termed high-culture, these figures must be considerably increased.

To arrive at an estimation of the produce of a park moderately well situated is particularly difficult; the ordinary parker keeps no books and can furnish no profit and loss accounts and without records extending over a considerable number of years we can obtain no really reliable estimate of average profits.

To attempt an approximation, we may take it that the 8,000 collector tiles pertaining to a park of one hectare in area obtain a spat fall of 2½ millions of young. Sediment, inclement weather and numerous enemies thin the ranks of these brood oysters very considerably especially while they remain attached to the tiles, and the parker does fairly well if he rears one-third, say 800,000, to the saleable age of 18 months when the oyster should be 5 centimetres in diameter. The eventual amount of profit now depends upon the state of the market; according as the price may be from Rs. 6 to Rs. 9 per 1,000, the produce will realize a total of from Rs. 4,800 to Rs. 7,200 per hectare or roughly Rs. 2,000 to Rs. 3,000 per acre. The annual expenses of this park we had before estimated at from Rs. 1,100 to Rs. 1,700 per acre, giving a net profit of from Rs. 900 to Rs. 1,300 per acre. Unfortunately for the majority of the oyster culturists of Arcachon the bulk of the parks are of inferior situation and being handicapped by nature and the limitation of their owners' capital the profits they yield their lessees are very much smaller than in the estimation above given—in a word the profits of an Arcachon oyster culturist may range anywhere from Rs. 200 to Rs. 2,000 per acre according to situation.

These figures are liable to lead to false and exaggerated conceptions of the prosperity of the parkers unless

it be borne steadily in mind that Arcachon oyster culture is essentially an intensive industry and that to obtain profit, concentration of attention on quite a small area is imperative. Most of the calculations given have been in hectares; in reality the majority of the parks do not reach this and if we remember that a parker may have no more than an acre at his disposal we see that while the profits made under the conditions prevailing at Arcachon may in many cases ensure a comfortable living they do not endow more than a very small proportion of the number with riches. With a fair degree of comfort assured if economy be practised the chief benefits which oyster culture confers upon the maritime population of Arcachon are the sense of independence it confers, the self-respect it induces, and the enterprising spirit which it fosters.

(*i*) *Present conditions and future prospects of the industry.*

For several years past Arcachon producers have found the disposal of their oysters at remunerative prices a matter of the utmost difficulty. Large profits can still be made by those possessing first-class locations, a fair living is within reach of those having moderately good or second-class holdings, but to those whose parks fall into within the third and last category—and these are in the majority—times have been and continue to be difficult; to these latter their trade gives either a bare subsistence or it is carried on as a supplementary calling to another and more reliable one. In consequence of the reduced profits now ruling, the less favourably situated parks are rapidly passing out of cultivation, such as give remunerative returns only when prices attain a high level.

In 1905, 6,006 parks comprising a total area of 3,095 hectares (say 8,000 acres) were in occupation; the produce being estimated at 420,000,000 sold at an average of Rs. 7 per 1,000. In 1906 the number of concessions fell to 4,580, a large number of the less

prosperous holders selling their rights and their stock for what they would fetch in order to buy motor boats and gear to engage in the then rapidly developing and better paying sardine fishery. The number of holdings still further decreased in 1907, 3,895 only being registered, and in this year we find also a fall in the area cultivated—the total surface under culture being under 3,000 hectares for the first time since 1885. The precise area occupied was 2,833 hectares. Shrinkage in the area cultivated still continues, and I understand that at the end of 1908 less than 3,000 parks covering a superficies of not more than 2,500 hectares were in exploitation.

Three principal causes account for the decreased profits of the Arcachon oyster culturist. They are over-production, lack of co-operation and organization among the producers, and displacement of the indigenous oyster by the cheaper and hardier Portuguese species.

The first and the last of these adverse factors are correlated in large measure, for, were it not for the steadily increasing competition of the Portuguese, the Arcachon native would be readily saleable still. As it is, the French public has learned to appreciate the good value obtained when it purchases the Portuguese; the oyster parkers of the famous fattening centres of Oléron and Marennes have realized that the cheapness of the newcomer has created an oyster-consuming cliéntele among classes who could not afford this luxury so long as the higher priced indigenous oyster held the field alone, and have adapted their business accordingly. They have arranged their operations so that they can cater alike for the wealthy and the comparatively poor; for the one they provide the expensive luscious green Marennes native, for the other the large and succulent Portuguese, frequently combining the culture of both and maintaining thereby a large portion of the prosperity of pre-Portuguese days. Not so the Arcachon culturists; they boycotted the Portuguese as long as they could and they refused to give its production any attention till they found the sale of their wares falling off before the steady

demand of a large section of the public for Portuguese. They are now falling into line with other French centres; in 1907, their sales of Portuguese oysters till then negligible, suddenly rose to a value of 809,000 francs (Rs. 4,85,400), and are now steadily rising annually. The bulk of the parkers, however, still limit their efforts to the culture of the native oyster and as the competition of the Portuguese renders their oysters both low priced and slow of sale, stock has accumulated to such a great extent—about 1,000,000,000 in 1907—as to entail overcrowding with its train of baneful consequences, growth stunting and disease. What intensifies the trouble, if indeed it is not largely accountable for it, is the restriction upon liberty of sale imposed upon the local trade years ago at the request of the culturists themselves, whereby no oysters may be despatched outside the basin under 5 cms. diameter. Arcachon trade has never been primarily one of sale to the general public; it has been largely directed to the supply of stock for fattening to oyster centres which do not produce sufficient brood for their rearing grounds and greening claires. These take decreasing quantities year by year and the position is one which the Arcachon parkers find difficult to adjust. Arcachon on the whole, is not well adapted to fatten large quantities of first class oysters. The Arcachon oyster when mature has the reputation of being distinctly second class and without the advantage of a fattening sojourn on better situated grounds it is difficult of sale in competition with the Portuguese, its size being distinctly inferior and its superiority in flavour a matter of small moment with those who have become accustomed to the Portuguese; for cooking purposes the latter is the more useful.

Distinct relief to the Arcachon trade would probably be felt if the producers were at liberty to sell their brood at any age they please; they would then find an outlet with an entirely different class of buyers to those who take the 5 centimetre size, for example, the English trade, which not infrequently buys very young brood in great

quantities from Auray, would be open to favourable offers which Arcachon with its super-abundant spat falls is particularly well fitted to make. As an unprejudiced outsider I should certainly advise the Arcachon parkers to obtain complete liberty of trade, and at the same time to take steps to limit the annual production both in the interests of higher prices and to insure improvement in the health and the rate of growth of the stock reared.

Lack of co-operation and organization are defects largely consequent upon that chief merit of the Arcachon system of oyster culture—the multiplicity of small holdings. With over 2,000 concessionaires concerned, the majority plain fishermen and sailors, it is most difficult to secure co-ordination of effort. Several times, in 1886, 1890, 1892, and in 1904, Associations have been formed to forward by co-operation and combined organization the well-being of the local oyster industry. Time after time these Associations have lapsed through inanition or disagreement and no combination now exists among producers for mutual benefit. A certain amount of good has undoubtedly resulted from the various efforts which have been made, but the failures have been so many that Arcachon parkers are now inclined to look askance at any new proposition to found another mutual society to promote the common welfare. This is greatly to be deplored, for such a society can work good in many directions. It is the medium through which excessive over-production may be combated ; if directed aright, it should be able to do much to increase the consumption of its members' products ; depot agents to push these goods might be appointed in all great centres of population in France, Belgium, England and Switzerland (German tariffs are an effective barrier to entry into that country). Incessant agitation should be kept up to obtain better transport facilities ; no peace should be given the local Railway Company till it consents to a substantial lowering of rates, and to this end the Association would bring the whole weight of its influence to bear upon Government. In passing I may mention

that the freight on oysters from Arcachon to Bordeaux, a distance of 35 miles, is Rs. 8 per ton, an exceedingly heavy rate. The best argument for a great lowering of the rates lies in the practical certainty that with fair organization of the trade such rates would eventuate in largely increased exports from Arcachon by rail. But in spite of a supposed penchant for political revolution, the French peasant-proprietors—to whom the Arcachon oyster culturists belong—are among the most conservative of people.

In connection with this matter of co-operation, it is noteworthy to observe that no mutual or other insurance Associations exist to ensure the members against extraordinary losses, although such exist among the sea-fishermen of the district.

Apart however from the potential good effects of co-operation and organization among the producers upon the Arcachon oyster trade, the stress of past years has been engaged automatically in gradually improving matters. The worst of the parks are passing out of cultivation, and with a large diminution in the area of the parks, overproduction is becoming less marked. At the most critical moment, when many parkers were feeling the pinch of bad trade most keenly, the rising sardine fishery with its promise of large profits called for numerous volunteers, for men as fishermen and for women as hands in the canning factories.

With the exercise of patience, restraint, mutual help and reasonable enterprise a fairly bright future should be assured for the Arcachon oyster industry. There is no call for discouragement and there is definite promise of better times; the signs of improvement are already apparent. Certainly the larger cultivators, the men disposing of ample working capital, are not disheartened and are making good profits as I learned most definitely during my recent visit. From this the holders of small concessions should take example and by co-operation attain the same satisfactory results.

V.—PRINCIPAL CHARACTERISTICS OF OTHER EUROPEAN SYSTEMS OF OYSTER CULTIVATION.

In concluding this short review of the Arcachon oyster culture industry as it presented itself to my eyes in the summer of last year, it will be of some value if I note briefly the outstanding features of difference met with in the systems practised elsewhere in Europe.

The scale of development characterising oyster farming in those European countries where the industry in some form or other is worked on any important scale runs as follows in order of specialization, viz., Germany, Portugal, Spain and Belgium, England, Italy, Holland, France.

Germany is the lowest in the scale of oyster-farming countries and indeed nothing deserving the name of cultivation exists there, the severity of the German winter rendering foreshore operations a matter of too great expense, difficulty and risk. Under the circumstances probably the wisest course has been followed, the extensive natural oyster beds which cover a great extent of the bottom of the shallow Wattenmeer, lying between the west coast of Schleswig-Holstein and the north Frisian Islands, being leased out by the Government to a single firm. Great care is taken by the Fishery Inspectors to prevent more oysters being removed from the beds than are replaced annually by new growth. These beds are an instance of the beneficent results which accrue when the intelligent regulation and production of a natural fishery be taken in hand *prior to excessive depletion.* It was the want of such prevision as the Germans have shown, which has caused the ruin of almost all the English and French natural beds and, nearer home, the local beds in the Sind creeks.

In Portugal the reproduction of the natural beds of the Portuguese oyster (*O. angulata*) is so enormous that no other efforts are required to stock the foreshore laying grounds, than the collection of young brood from the

gravel and shells of the bottom of the Tagus estuary. No other culture is practised nor is any required. It should here be noted that the Portuguese oyster is different in method of spatting and general habits from the oyster (*O. edulis*) indigenous to England, France and Germany ; it is also hardier and with a much greater appetite than the "native"—as a consequence its growth is more rapid.

Culture in Spain and Belgium consists almost entirely in relaying young oysters obtained principally from the chief centres of production in France.

In England a great deal of the same elementary culture takes place, the stock being obtained from France, Holland, and even the United States. At Whitstable and along the Essex coast cultivation is carried several steps further. In these localities there exist certain "common grounds" open to dredging by any one, whereon in favourable years considerable deposits of spat are found. This is dredged up and sold to culturists who lay the spat first on that particular portion of their grounds where growth is known to be rapid. At a later date the oysters are re-dredged and placed elsewhere to fatten. Most of the operations entail dredging, a fleet of handy dredging smacks being employed by the Corporations and Joint Stock Companies which control these fisheries. The Colchester authorities also employ a small steamer built and fitted specially for this work and experiments are at present being carried out with a view to replace the smacks by handy motor boats. On the Essex coast special precautions are necessary during winter to safeguard the stock from frost and the harmful effects of snow water. No natural oyster beds now exist and no breeding reserves are maintained at any of these English oyster culture centres ; the stock of marketable oysters in the various estuarine concessions is supposed to serve. As a consequence of this, the spat-fall is frequently inadequate for local requirements and in such years large consignments of brood oysters are imported from France, chiefly from Auray. This necessitates heavy additional expenditure both *per se* and indirectly, as oysters reared from

French brood do not realize nearly such high prices as do real natives. After three years' sojourn in English waters their flavour is almost as good as that of a true native, but the little tell-tale cement mark remaining from the time they were detached from the collectors reveals their foreign birth and the astute middleman, who does not, I fear, disdain to sell them to the public as natives, demands and receives a heavy reduction from "native" prices when purchasing any of this class of oyster.

Cultivation in Holland is based upon the French system as practised at Arcachon. To meet local conditions a number of modifications have been introduced, the most important being that the collector tiles are not stacked in ruches but are piled loose in low wall-like rows parallel with the shore at low tide level. Usually there are several ranks of these tiles ranged one behind the other. The reason for this modification which conduces greatly to simplicity and economy in working, is the stiffer nature of the bottom on these Dutch collecting grounds. To guard against frost, the tiles with their catch of spat are transferred in autumn to pits above tide-mark, where they remain till the spring when the brood-oysters are detached from the tiles and placed in ambulances. Early in the next autumn they are sown on the deep-water section of the concessionaire's holding where they remain for two or three years till they become of marketable size and condition.

Much of the prosperity of Dutch oyster farming is due to the abundance of spat on their grounds, the product of the immense breeding reserves which have accumulated along the seaward base of the coast dykes in consequence of an old regulation which prohibits dredging within 547 yards of these great embankments.

Oyster culture in Italy antedates that in any other country and the methods there pursued, in one instance dating back to a successful Roman experiment made at the beginning of the Christian era, inspired Coste with the ideas from which gradually developed the present great French industry.

The most extensive of Italian oyster-farming grounds are situated in the Mare Piccolo, a shallow landlocked bay at the head of the Gulf of Tarentum. Here oyster farming is carried on not on the sea bottom but at different levels in the water itself, a system thoroughly scientific in theory and equally sound in commercial practice in this particularly conditioned locality. The plan adopted is to drive a number of posts into the firm calcareous sand forming the bottom of the basin so that a portion may project beyond the surface of the water. These posts or piles are usually placed at the four corners of a culture plot ; between them extends a network of cords from which are hung bundles or fascines of brushwood. Oyster spat settles usually upon these in great abundance, the play of the water upon the fascines as they sway about at the end of their suspensory cord preventing any accumulation of mud. Bathed in the nutrient tide these oysters grow much more rapidly than if laid upon the bottom, a fact the farmers recognize precisely, for all oysters which become detached and fall to the bottom owing to the decay of the bark to which they were attached, are gathered up and placed in baskets to be again suspended from the overhead cordage.

The highest development of oyster culture is however seen in the fattening and greening claires of Marennes and other places on the Seudre in France. These claires are not the rough and ready shallow ponds covered twice daily by the tide which Arcachon parkers find sufficient for their needs ; they are elaborate reservoirs excavated on land and connected with the sea by sluices. They are above the level of neap tides and the water within can be renewed only during spring tide. Even then the whole water is not emptied out and renewed ; only enough water is changed to keep the contents in health. The food of the oysters being fattened and greened is supplied by the enormous production of diatoms induced by the shallowness and peculiarly favourable composition of the soil forming the bottom and walls of the claires themselves. The details of this branch of oyster culture are of the

highest interest but this is not the place to do more than make a passing reference to them in order to round off this enumeration of the principal variations and developments of oyster farming.

In the case of the above mentioned countries, with the exception of France and perhaps of Italy, the State has adopted the system of obtaining the highest rental possible for concessions to fish and farm oysters within its estuaries and harbours. This has resulted in throwing the industry almost entirely into the hands of capitalists and wealthy Corporations. The French system of exploiting the oyster resources of its coasts is based on an entirely different principle; the fundamental idea in this case is to encourage the small holder, to build up a numerous class of independent culturists and to help them to success by charging trifling rentals for the areas conceded for cultural purposes. The French Government is extremely solicitous to maintain a large and hardy maritime population; the adequate manning of its navy is a consideration to which it has long given the utmost attention and the privilege of small oyster-farming concessions is one of the means it employs to strengthen that section of the population from which the personnel of its naval fleet is derived.

VI.—APPLICABILITY OF FRENCH METHODS OF OYSTER-CULTURE IN INDIA.

(a) *The conditions prevailing in India.*

Numerous small natural oyster beds exist in the creeks and estuaries of India but no oyster culture is practised anywhere. Save in Sind and Kutch no Government has asserted authority over beds of edible oysters, although elsewhere such are almost universally considered as pertaining exclusively to the State. In the Madras Presidency at the present time no exploitation takes place save that here and there a man may cull a few oysters to fill a small order for a club or hotel. Demand is all but absent, to a large extent due to distrust of the

hygienic conditions under which the oysters grow and to the lack of any organized distributing agency. Looking to the woeful history of the beds in Sind we should be thankful for this lack of demand as it has prevented the extinction of the beds and thus furnishes the opportunity to build up some useful culture system without being beset by the difficulties that would be present if depletion had taken place. To show the extreme hazard of postponing the enforcement of regulations for the protection of natural beds against uncontrolled exploitation till diminished production becomes clamant for assistance, we have already dealt with the history of the Arcachon beds during the first half of last century at some length. India shows a virtual parallel in the case of the Sind beds which a few years ago were exceedingly prolific and made Karachi famous for the excellence of its oysters throughout Northern India ; to-day the supply is not sufficient to meet local demand and the beds are practically wrecked. To point the necessity for the early assumption by the Government of effectual control over the principal oyster beds in the Madras Presidency, it may be very useful to tell the story briefly of these particular oyster beds on the coast of Sind.

The oysters of that district have been held in high estimation by Europeans ever since the British occupation in 1843, but the reputation was largely local till the time when Karachi became connected with the Railway system of the Punjab and the North-Western Provinces. Ice was available at the same time and as a consequence of these two factors and of the excellence of the mollusc, a brisk and rapidly expanding trade sprang up in the supply of oysters to regimental messes, clubs, hotels and private individuals. To save freight and ensure proper icing the oysters were shucked before despatch, the sendings being made in sealed tin canisters embedded in broken ice. Low prices and good quality encouraged consumption, and many thousands of dozens were despatched by train annually in the hey-day of the trade. Towards the end of this period the price paid by oyster

traders to the villagers of the creeks who did most of the collecting was at the rate of Rs. 3 per 100 dozen, fractionally less than half an anna per dozen. Considering that several score men were engaged in the business its great extent may be readily inferred from this rate.

In 1894, considerably greater efforts were required to gather a given quantity than in previous years and the middle-men had to increase their purchase rate to Rs. 5 per 100 dozen, as the villagers found it no longer remunerative to work for Rs. 3 per 100 dozen. The first note of alarm for the depletion of the beds was sounded in this year, the Customs authorities at Karachi reporting to Government that the beds in all the creeks were being exhausted at a rapid rate, so much so that several Karachi firms interested in the supply of oysters to up-country clients were trying to arrange for supplies from the Baluchistan coast to make up for the ever increasing difficulty in obtaining sufficient supplies from the home district. One officer reported that masses of empty shells were all that remained to mark the spots where at one time boat loads of oysters were obtainable. He predicted the entire exhaustion of the beds unless measures were at once adopted to prevent further uncontrolled spoliation. The next year the scarcity was further emphasized and instances are given of oyster boats returning to Karachi after eight to ten days' search in the creeks with not even a quarter load.

The authorities were thoroughly aroused to the gravity of the situation and since 1896 the following measures have been adopted in the endeavour to prevent further exhaustion of the beds and to renew their prosperity, namely :—

(*a*) The observance of a close season from 15th April to 1st October in each year.

(*b*) The closing of the creeks by compartments to oyster fishing in addition to the annual close-season, a two-years' rotation being observed.

(*c*) Prohibition of the removal of oysters less than 2 inches or more than 6 inches in length.

(*d*) The licensing of the fishermen engaged in collecting oysters for market, in order the better to exercise control over their actions.

These efforts to improve the position have been in force over a period of thirteen years and to-day after a careful examination of the principal creeks on the Sind Coast where oysters were once abundant, I am reluctantly obliged to describe them as completely exhausted, and as no longer of any commercial value. To take one instance—one very extensive creek with several far extending branches which had been closed to fishing, was re-opened during my inspection and I came across one oyster boat, the first and only one on the scene. Every bed in the main creek and its branches had been despoiled during the two days this boat's crew had been at work; practically every oyster that had grown up during the period of closure had been taken away and withal the boat was not full and the men were deploring the unfruitfulness of their labours. Well might the late Chief Collector of Customs in Sind, Mr. E. H. Aitken, the lamented "Eha", write in 1904 in a letter to the Commissioner, "We do not need to look for any other explanation of the almost total disappearance of edible oysters from places which used to furnish them in abundance than the reckless destruction of them which has followed upon the increased demand since the practice of packing them in ice made it possible to despatch them to distant stations all over the interior."

At the present time none of the Sind beds can possibly become commercially productive unless they be given a prolonged rest and some simple cultural measures be introduced to assist nature. A rest, by closure for several years, by itself will be of doubtful benefit. It may be of appreciable advantage, but there is no certainty about the results. I am indeed inclined to think that matters have gone too far for nature unaided to renew the old prosperity within any reasonable time-limit. Besides, the area of hard bottom available for oyster attachment and growth is very limited in the

creeks—tiny reefs of dead shells encompassed by vast expanses of soft mud; I fear the level of these reefs has been so reduced by the spoliation of the oystermen that the mud around is covering up and fouling the greater part of the available cultch and that even if oyster spat be present in the water of the creeks it may be lost for want of clean surfaces for its attachment. Hence the need for man to come to nature's help and among other measures to ensure that the area occupied by clean cultch shall be increased. It will probably be found necessary also to introduce quantities of mother-oysters from outside localities to provide the supplies of spat needed to re-populate the exhausted beds.

Kutch has been linked with Sind as the other Indian locality where the State has exercised some control over the edible oyster trade. In this case it has been restricted to the imposition of a gradually increasing export tax upon each boat load of oysters collected for the Karachi market on the Kutch coast. For some years previous to 1904, the rate levied was Rs. 15 per boat load. In 1904, it was raised to Rs. 50 as the Kutch Durbar, fearing that their beds should suffer the fate of exhaustion which had fallen upon those of Sind, decided to endeavour to diminish the drain on their beds by this heavy increase in the export charge. The Karachi oyster merchants endeavoured to evade the effect of this increased levy by despatching boats of greater capacity, and the Kutch Durbar has had, I understand, to double the charge, which when last I heard, was understood to be Rs. 100 per boat load. In view of the risks of the voyage from Kutch to Karachi, this is well nigh prohibitive and so while the Kutch authorities may be conserving their beds they are burking the oyster trade of their State.

Before I leave this portion of my subject, it is necessary to state that the mode of occurrence and the habits of the Sind oysters approximate very closely to those typical of oyster-patches in the muddy backwaters of the Madras coasts. One description will serve for both localities, although the oysters themselves appear to

belong to separate species, that of Sind being characterized by a white adductor scar, that of Madras (Pulicat and Ennore as typical examples) being purplish black. Both species appear to be related to the robust mud-loving Portuguese oyster of European commerce (*O. angulata*); like the latter the sexes in these Indian species are separate.

In the Indus creeks on the coast of Sind, no rocky out-crops occur, neither pebbles nor gravel is to be found anywhere. The cultch to which the oysters adhere consists solely of the accumulated shells of former oyster generations. In almost all cases the oyster patches occur close to the low-water level of spring-tides; usually the beds are more or less uncovered at such times. The oysters, nearly all dead, seen in the Sind creeks may attain relatively enormous size. I have note of a dead valve measuring 15 inches in length and I have seen several in which the hinge region alone measured from 7 to 8 inches in length. When growing in muddy creeks the Sind oysters are characteristically elongate, long and narrow and typical "slipper-oysters." The oysters in any patch tend to segregate into clusters composed usually of from 5 to 12 or more individuals. A very notable feature characterising the habit of growth is the way the oysters in these clumps retain their own individuality; each keeps the greater part of its shell free from cohesion with those of its neighbours due to a slight amount of radial divergence in the direction of growth among the several oysters. This habit produces very serviceable clusters, readily separable into units as the area of cohesion is small and limited to the massive dorsal region of the valves. The joint made by the adherent surfaces is also imperfect, rendered weak by the muddy scum present on the older valves when the younger come to attach to them.

Similar conditions entail similar habits in the case of muddy creeks and channels in estuaries and backwaters on the Madras coast, but there are many localities where stones and more or less consolidated and stable sandy

mud occur affording less precarious footing for the oysters. In such places the oysters are found to be less disposed to cluster, the slipper-form is less well marked and a varying proportion of the oysters exhibit a tendency to broaden and assume the more acceptable outline of the English native. In Pulicat Lake for instance we find considerable deposits in shallow water on a fairly stiff bottom of muddy sand under ideal conditions for culture, but it is noteworthy that so far as the history of these deposits can be traced, they are not natural beds but have arisen accidentally through human agency; they appear to be the offspring of store-oysters laid down in these places years ago by oystermen in days when a fair demand for Pulicat oysters existed in Madras. The natural beds are those rising from the bottom of muddy channels and creeks, exactly as is seen in the case of the Sind creeks.

The most extensive beds of oysters in Southern India with which I am acquainted are those of Cochin harbour. These occupy a very extensive area and are never uncovered by the tide. Few are used as food and no export trade is carried on, nevertheless large quantities are collected annually by means of shallow-water diving. (Four to six feet of water is the usual depth over these beds.) The use to which they are put is interesting—they are used as backing for the piles along canal banks and to fill hollows and serve as foundations for dwelling houses in the low-lying marshy sections of the native town.

(*b*) *The extent to which culture is possible in India; character of the control regulations and assistance needful.*

It behoves Madras to profit from the object lesson provided by the complete depletion of the once prosperous Sind oyster beds for lack of adequate protective regulations and to make an early application of well-considered and easily enforced bye-laws for the safeguarding of presently existing beds in those selected

localities which may be considered worthy of attention and suitable for attempting the development of an oyster industry of considerable extent. When once the organization of such local measures becomes effective then the simpler of the culture methods as developed at Arcachon may be introduced and experimented with and concurrently the example of Karachi emulated in catering for the home market by means of the rail despatch of shucked oysters in ice to up-country and distant stations; in the event of Pulicat Lake being made a centre for this industry, the facilities afforded by the East Coast Railway for rapid access to the great markets of Calcutta are ideal. In the cold weather season iced sendings should reach consumers in Calcutta in excellent condition if the most elementary precautions be observed. Local demand in Madras city may also be relied on to develop to considerable dimensions if oysters of recognized good quality and known to be grown under wholesome conditions be regularly obtainable; in this case the oysters may be delivered in their shells, unshucked. If the trade be handled in proper fashion home demand may be counted upon to develop rapidly and should prove equal to the production for some years to come. Eventually should the production prove greatly in excess of these requirements, the surplus should readily find a profitable outlet in the form of those preserved oyster products so popular in America. Desiccated oysters are also in large demand in China but I am doubtful if this form of trade would pay producers seeing that prices for this product are relatively very low and that Indian oystermen would be necessarily handicapped with the expenses of culture as the areas of our natural oyster beds are restricted.

So far as my personal acquaintance with the two coasts of Madras extends, I consider that the greater potentialities of profitable oyster culture lie on the East Coast. Excluding Cochin and Travancore I know of no really good locality where culture on an extensive and economical scale can be attempted on the Malabar and

South Canara coast line; along this coast there is no possibility of oyster culture in the open sea; there are no land-locked bays with permanent and wide seaward entrances; in their place are numerous wide river-estuaries connected with more or less extensive systems of backwaters; at present I know of none within British limits suitable for oyster culture. All suffer from the disability of being subject to the action of long-continued torrents of fresh-water floods during the rainy season. These floods last so long that oysters have no chance of surviving through the rainy season in those reaches where culture alone would pay. Apart from Cochin, the oysters now supplied for table use on the Malabar coast come almost entirely from small rocky patches near the shore or just within the entrances of estuaries.

On the East Coast the conditions for oyster culture are more favourable. The annual rainfall is light and an ever increasing network of irrigation channels, with their complement of tanks and anicuts, intercepts in large measure the rush of flood water to the sea when the rains are on and by this limiting and moderating influence counteracts to a very large degree the injurious effect which long continued floods have upon estuarine oyster beds. No culture can be successful if the specific gravity of the water bathing the beds falls appreciably lower than 1·015 for any considerable period. We have seen that at Arcachon the very moderate floods which an abnormally rainy season induces entail heavy loss through disease and death although the basin receives a vast volume of tidal water twice a day.

It is among the estuaries and backwaters of the East Coast that we must search for the most suitable localities to develop oyster fisheries. I have already in Bulletin No. 4 indicated Pulicat Lake as well adapted for this purpose; its proximity to Madras would facilitate the supervision of operations. It already possesses several extensive patches of vigorous oysters to supply the needful spat; to the east of the Pulicat Islands extends a large shallow water area with sufficiently

consolidated bottom to serve well the purposes of an oyster culturist. The situation is ideal for the purpose, bounded as it is on two sides by scattered patches of adult oysters, with a bottom of sandy mud stiff enough for collector tiles to be laid out in piles as in Holland without the protection of expensive collector cases (ruches) ; food supply in the form of diatoms is superabundant, the shallowness of the water, 1 to 2 feet at low tide, admits of operations being carried on daily with the greatest of ease, and proximity to the channel connecting the lake with the sea ensures the maximum of those conditions which make for health and rapidity of growth. Should the experiment prove successful and a larger area require to be devoted to culture, over 1,000 acres are available on the flats between Karimanal and the mainland, where conditions prevail little if at all inferior to those characterising the flats first mentioned.

The creeks around Nizampatam near the embouchure of the Kistna, and those near certain of the Gódávari outlets are also suggested as likely to be suitable but as I have not yet had an opportunity of visiting these places, I place Pulicat Lake in the forefront for the present as the most adaptable and accessible locality for the inauguration of simple cultural methods. It is however absolutely essential to the carrying out of any scheme that steps be taken at an early date to afford protection to the natural oyster beds now existing in Pulicat Lake and other backwaters where culture may eventually become possible. It is infinitely easier to destroy a natural bed than it is to re-create it. The present time too is specially critical seeing that the middleman is turning attention in increasing degree to exploiting the profits of our fisheries. A vigorous campaign of one energetic dealer would go far in a single season to occasion almost irreparable damage to the Pulicat beds, so limited is their extent. That the Government has the power to dispose of these beds at will and to enforce regulations for their fishing is justified by the accepted laws of all nations which give this matter

attention—even in India we have ample precedent in the action of the Bombay Government which under section 37 of their Land Revenue Code (Bombay Act V of 1879) exercises the rights of proprietorship over the oyster beds in the Sind Creeks, in the levy of heavy duties by the Kutch Durbar on oysters removed from the creeks on their coast, and lastly in the power which the Madras Government through the medium of the Public Works Department has taken to itself to lease out the collection of small clams (*matti*) along the course of the Buckingham Canal and actually within Pulicat Lake itself. The action of the French Government in regard to Arcachon has also been detailed at some length on a preceding page, and there can be, I think, no doubt as to the proprietorship of the State in all shell-fish fisheries in areas affected by tidal waters. It is desirable, therefore, if the Government desires to foster an edible oyster fishery that notification, in whatever may be the proper legal manner, be made interdicting till further notice, under suitable penalty, all collection and dealing in edible oysters from the beds in Pulicat Lake. The beds around Pulicat being thus protected consideration may then be given to the mode in which development of these dormant fishery resources may best be effected. Here as in other new departures in the country, it will be necessary for the State to do the pioneering. I would therefore propose for the consideration of Government that the Fisheries Department be directed to take a small area of suitable bottom in Pulicat Lake and there carry on experiments based upon simplified Arcachon methods as described in the preceding pages, directed towards ascertaining the most economical and effective methods of oyster culture suitable to the particular conditions prevailing in a tropical country in general and in Pulicat Lake in particular. These experiments should be directed to ascertain—

(*a*) the best form of collector to use,

(*b*) the most suitable method of arranging the collectors,

(*c*) the proper season at which to place the collectors in position,

(*d*) the age at which détroquage should take place,

(*e*) the special enemies and dangers besetting brood and adult oysters in the Pulicat parks, and the best methods to ensure protection against such dangers,

(*f*) the conditions and localities in the Lake most favourable to rapid growth and fattening,

(*g*) the manner in which the adult oysters may best be prepared for market and conveyed in good condition to their destination.

Finally special attention must be given to the devising of means for carrying out all operations with a minimum of expense in order that the price at which the oysters reach the consumers shall be low enough to create a large demand and yet yield a margin of profit to the culturist sufficiently large to induce some of the people of the district to enter upon oyster culture upon similar lines. In this connection I trust that preference may be given to small men rather than to the capitalist ; this is the principle adopted by the French Government in its administration of the oyster parks of Arcachon, and, as I have shown, it has resulted in the creation of thousands of small holdings worked in large part by the families of renters. The majority of the men are proprietors and not day-labourers as are English oyster-fishers and the result is that Arcachon oystermen are both better circumstanced and of greater independence and enterprise than their English brethren who have usually no special interest in their work save the wage they earn.

It will however be time enough to consider the conditions of rental and the safeguards to be imposed against the monopolist after experiments shall have demonstrated oyster culture to be economically successful in this country. I foresee difficulties but I do not believe them to be insurmountable.

TUTICORIN,
31st January 1910.

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